PALÆONTOGRAPHICAL SOCIETY.

VOL. LX.

THE PLEISTOCENE BEARS.

PAGES 1—35; PLATES I—VIII.

THE FISHES OF THE OLD RED SANDSTONE.

PART II, NO. 3.

PAGES 119—130; PLATES XXVII—XXXI.

THE CRETACEOUS LAMELLIBRANCHIA.

VOL. II, PART III.

PAGES 97—132; PLATES XII—XIX.

THE LOWER PALÆOZOIC TRILOBITES OF GIRVAN.

PART III.

PAGES 97—186; TITLE-PAGE AND INDEX; PLATES XIV—XX.

THE CAMBRIAN TRILOBITES.

PART I.

PAGES 1—28; PLATES I, II.

BRITISH GRAPTOLITES.

PART V.

PAGES lxxiii—xcvi, 181—216; PLATES XXVI, XXVII.

ISSUED FOR 1906.

PALÆONTOGRAPHICAL SOCIETY.

VOLUME LX.

CONTAINING

ISSUED FOR 1906.

LONDON:

PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.

AGENTS FOR THE SOCIETY:

DULAU AND CO., 37, SOHO SQUARE, W.

DECEMBER, 1906.

THE PALÆONTOGRAPHICAL SOCIETY was established in the year 1847, for the purpose of figuring and describing British Fossils.

Each person subscribing ONE GUINEA *is considered a Member of the Society, and is entitled to the Volume issued for the Year to which the Subscription relates. The price of the Volume to Non-subscribers is* TWENTY-FIVE SHILLINGS NET.

Subscriptions are considered to be due on the 1st of January in each year.

The Annual Volumes are now issued in *two forms of Binding:* 1st, with all the Monographs stitched together and enclosed in one cover; 2nd, with each of the Monographs in a paper cover, and the whole of the separate parts enclosed in an envelope. Members wishing to obtain the Volume arranged in the LATTER FORM are requested to communicate with the Secretary.

Most of the *back volumes* are in stock. Monographs or parts of Monographs already published can be obtained, apart from the annual volumes, from Messrs. DULAU AND CO., 37, Soho Square, London, W., who will forward a complete price list on application.

Members desirous of forwarding the objects of the Society can be provided with plates and circulars for distribution on application to the Secretary, Dr. A. SMITH WOODWARD, British Museum (Nat. Hist.), South Kensington, London, S.W.

The following Monographs are in course of publication :

The Fossil Sponges, by Dr. G. J. Hinde.

The Graptolites, by Prof. Lapworth, Miss Elles, and Miss Wood.

The Cambrian Trilobites, by Mr. Philip Lake.

The Fossil Echinodermata, Cretaceous, by Mr. W. K. Spencer.

The Cretaceous Lamellibranchia, by Mr. H. Woods.

The Inferior Oolite Ammonites, by Mr. S. S. Buckman.

The Sirenoid Ganoids, the Palæoniscid Fishes of the Carboniferous Formation, and the Fishes of the Old Red Sandstone, by Dr. R. H. Traquair.

The Fishes of the English Chalk, by Dr. A. Smith Woodward.

The Fauna of the Devonian Formation of the South of England, by the Rev. G. F. Whidborne.

The Cornbrash Fauna, by the Rev. J. F. Blake.

ANNUAL REPORT

OF THE

PALÆONTOGRAPHICAL SOCIETY, 1906,

WITH

LIST

OF

The Council, Secretaries, and Members

AND

A LIST OF THE CONTENTS OF THE VOLUMES ALREADY PUBLISHED.

Council and Officers elected March, 1906.

President.

HENRY WOODWARD, Esq., LL.D., F.R.S., F.G.S.

Vice-Presidents.

Rev. Canon Bonney, D.Sc., F.R.S.
G. J. Hinde, Esq., Ph.D., F.R.S.
W. H. Hudleston, Esq., M.A., F.R.S.
E. T. Newton, Esq., F.R.S.

Council.

F. A. Bather, Esq., M.A., D.Sc., F.G.S.
[Rev. J. F. Blake, M.A., F.G.S.*]
H. W. Burrows, Esq., F.G.S.
Miss Margaret Crosfield.
Upfield Green, Esq., F.G.S.
F. W. Harmer, Esq., F.G.S.
F. L. Kitchin, Esq., M.A., Ph.D., F.G.S.
P. Lake, Esq., M.A., F.G.S.
Thomas Leighton, Esq., F.G.S.
The Right Rev. Bishop Mitchinson, D.C.L.
F. R. Cowper Reed, Esq., M.A., F.G.S.
Clement Reid, Esq., F.R.S.
F. W. Rudler, Esq., I.S.O., F.G.S.
W. P. D. Stebbing, Esq., F.G.S.
A. Strahan, Esq., M.A., F.R.S.
Prof. W. W. Watts, M.A., F.R.S.
Rev. G. F. Whidborne, M.A., F.G.S.

Treasurer.

G. J. Hinde, Esq., Ph.D., F.R.S., F.G.S.

Secretary.

A. Smith Woodward, Esq., LL.D., F.R.S., British Museum (Nat. Hist.), South Kensington, London. S.W.

Local Secretaries.

Bath—Rev. H. H. Winwood, M.A., F.G.S.
Berlin—Messrs. Friedländer & Son.
Cambridge—H. Woods, Esq., M.A., F.G.S.
Cheltenham—L. Richardson, Esq., F.G.S.
Hertfordshire—J. Hopkinson, Esq., F.G.S.
Liverpool—Joseph Lomas, Esq., F.G.S.
Oxford—Prof. W. J. Sollas, F.R.S.
Staffordshire—Dr. Wheelton Hind, F.G.S.

* Deceased 7th July, 1906.

ANNUAL REPORT OF THE COUNCIL

FOR THE NINE MONTHS ENDING 31st DECEMBER, 1905.

READ AND ADOPTED AT THE

ANNUAL GENERAL MEETING,

HELD AT THE APARTMENTS OF THE GEOLOGICAL SOCIETY, BURLINGTON HOUSE, 30th MARCH, 1906.

DR. HENRY WOODWARD, F.R.S., PRESIDENT,

IN THE CHAIR.

IN accordance with the Council's resolution last year to balance the Society's accounts on 31st December instead of on 31st March as heretofore, their present Report refers only to the period of nine months between 1st April and 31st December, 1905. Notwithstanding this shortness of period, however, the Council have the gratification of recording a small balance in hand at the end of the year after paying the cost of the volume for 1905. Owing to the exceptional expenditure on recent volumes, it was necessary to reduce the plates to about the normal number, namely, twenty-eight altogether, of which eleven had already been drawn and paid for during previous years. The volume contains instalments of the Monographs of "Cretaceous Asteroidea," by Mr. W. K. Spencer (following the late Mr. Percy Sladen), of "Cretaceous Lamellibranchia," by Mr. H. Woods, and of "Inferior Oolite Ammonites," by Mr. S. S. Buckman; also the first part of a new "Monograph of the Fauna of the Cornbrash," by Rev. J. F. Blake, and the title-page and index of the second volume of Dr. Wheelton Hind's "Monograph of Carboniferous Lamellibranchiata."

The Balance Sheet does not admit of direct comparison with those of previous

years, but the Council regret to have to record serious losses among subscribers which they have not succeeded in making good. A most distinguished member, Dr. W. T. Blanford, F.R.S., died shortly after his election as Vice-President in June, 1905. Mrs. Percy Sladen, Rev. F. A. Walker, and Mr. W. H. Goss were also lost by death; while several libraries retired after a short period of subscription.

The Council desire to emphasise the importance of obtaining new subscribers to compensate for these losses, and are especially anxious to enlist the practical sympathy of all who are interested in the progress of Palæontology. The Monographs offered for publication are still more numerous than the Council are able to accept, and the completion of current Monographs would be much facilitated by additional funds to provide the requisite illustrations.

Thanks are due to the Geological Society for permission both to store the stock of back volumes and to hold the Council meetings and the Annual General Meeting in their apartments.

In conclusion, it is proposed that the retiring members of Council be Messrs. Bullen, Hopkinson, and Sollas; that the new Vice-President be Mr. Hudleston; that the new members be Messrs. H. W. Burrows, Clement Reid, and W. W. Watts; that the President be Dr. Henry Woodward; the Treasurer, Dr. G. J. Hinde; and the Secretary, Dr. A. Smith Woodward.

Annexed is the Balance-sheet.

THE PALÆONTOGRAPHICAL SOCIETY IN ACCOUNT WITH DR. GEORGE J. HINDE, F.R.S., TREASURER.

Cr. *For Nine Months, from March 31st to December 31st, 1905.* *Dr.*

Cr.		£	s.	d.	£	s.	d.
Balance from last Account					153	14	7
Subscriptions—1902–1904	7	7	7	0			
,, 1905	146	153	6	0			
,, 1906	10	10	10	0			
	163				171	3	0
Carriage paid by Members					0	9	7
Sale of back stock to Member					0	16	9
Sales by Messrs. Dulau & Co.					53	7	11
Dividend Natal Stock (less tax)					7	2	6
					£386	14	4

Dr.	£	s.	d.	£	s.	d.
Letterpress printing	80	3	10			
Small type tables, etc.	20	15	8			
Authors' corrections	21	11	6			
Paper	27	15	7			
Binding	39	16	3			
				190	2	10
Drawing and preparing illustrations	32	8	6			
Collotype and lithographic printing	77	7	6			
				109	16	0
Secretary's honorarium				52	10	0
Postage and stationery				3	19	5
Audit of stock				2	2	0
Fire Insurance				0	15	0
Bank charges and gratuity				0	17	10
Balance at Bank as per pass-book				26	11	3
				£386	14	4

We have examined the above account, compared it with the vouchers, and find it to be correct; we have also seen the receipt for £500 Natal 3 per cent. Consolidated Stock.

E. T. NEWTON.
F. W. RUDLER.
HENRY W. BURROWS.

March 10th, 1906.

LIST OF MEMBERS.*

CORRECTED TO 1st SEPTEMBER, 1906.

Aberdeen, University Library.
Adelaide (Australia) Public Library.
Adlard, R. E., Esq., Bartholomew Close. E.C.
Allen, E. G., Esq., 28, Henrietta Street, Covent Garden. W.C.
Allen, H. A., Esq., F.G.S., 28, Jermyn Street. S.W.
Amherst College, Mass., U.S.A.
Amsterdam, Royal Academy of Sciences.
Anderson, Tempest, Esq., M.D., F.G.S., 17, Stonegate, York.
Andrews, C. W., Esq., D.Sc., F.R.S., British Museum (Nat. Hist.), South Kensington. S.W.
Arlecdon and Frizington Public Library, Frizington, Cumberland.
Asher and Co , Messrs., 13, Bedford Street, Covent Garden, W.C.
Avebury, Right Hon. Lord, 15, Lombard Street. E.C.

Bakewell Naturalists' Club, *per* W. Storrs Fox, Esq., M.A., St. Anselm's, Bakewell.
Bâle (Switzerland), University Library.
Balston, W. E., Esq., F.G.S., Barvin, Potter's Bar.
Banks, W. H., Esq., Hergest Croft, Kington, Herefordshire.
Barclay, F. H., Esq., F.G.S., The Warren, Cromer, Norfolk.
Barnes, J., Esq., F.G.S., South Cliff House, Higher Broughton, Manchester.
Bath, Royal Literary and Scientific Institution.
Bather, F. A., Esq., M.A., D.Sc., F.G.S., British Museum (Nat. Hist.). S.W.
Battersea Public Library, Lavender Hill. S.W.
Bedford, His Grace the Duke of, K.G., Woburn Abbey, Bedfordshire.
Bedford Literary Institute, Bedford.
Belfast Linen Hall Library, Donegal Square North, Belfast.
Belfast, Queen's College.
Bell, W. H., Esq., F.G.S., Cleeve House, Seend, Melksham.
Bell and Bradfute, Messrs., 12, Bank Street, Edinburgh.
Bergen (Norway), Museums Bibliothek.

* The Members are requested to inform the Secretary of any errors or omissions in this list, and of any delay in the transmission of the Yearly Volumes.

Berkeley, Right Hon. Earl of, The Heath, Bear's Hill, near Abingdon.
Birkenhead Public Library, Birkenhead.
Birley, Miss Caroline, 14, Brunswick Gardens, Kensington. W.
Birmingham Free Public Library, Ratcliff Place, Birmingham.
Birmingham Library, Margaret Street, Birmingham.
Birmingham, University Library.
Blackburn Public Library, Blackburn.
Blackmore, Humphrey P., Esq., M.D., F.G.S., Salisbury.
Blathwayt, Lieut.-Col. Linley, Eagle House, Batheaston, Bath.
Blundell, Harold, Esq., Fairlawn, Harpenden, Herts.
Blyth, C. E., Esq., Siddington, Leamington.
Bolton, Chadwick Museum.
Bonn (Germany), Geological-Palæontological Institute of the University.
Bonney, Rev. Canon T. G., D.Sc., F.R.S., *Vice-President*, 9, Scroope Terrace, Cambridge.
Bootle-cum-Linacre Public Library, Bootle, Liverpool.
Bordeaux, University Library.
Boston Society of Natural History, Boston, Mass., U.S.A.
Boston Public Library, Boston, Mass., U.S.A.
Boulogne-sur-Mer (France), Bibliothèque Communale.
Bradley, F. L., Esq., F.G.S., Ingleside, Malvern Wells.
Brighton and Hove Natural History Society, Brighton.
Bristol Naturalists' Society, Geological Section, *per* B. A. Baker, Esq., 11, Westbury Park, Bristol.
Bristol Public Museum and Reference Library, Queen's Road, Bristol.
Bromley Naturalists' Society, 50, London Road, Bromley, Kent.
Bromley Public Library, Tweedy Road, Bromley, Kent.
Brown, Alexander Oestrand, Esq., 4, The Grove, Highgate. N.
Buchan-Hepburn, Sir Archibald, Smeaton-Hepburn, Preston Kirk, East Lothian. N.B.
Bullen, Rev. R. Ashington, B.A., F.G.S., Englemoor, Heathside Road, Woking.
Burrows, Henry W., Esq., F.G.S., 17, Victoria Street. S.W.
Burslem Public Library, Burslem.
Buxton Public Library, Town Hall, Buxton.

Cambridge, Peterhouse.
Cambridge Philosophical Society's Library, New Museums, Cambridge.
Cambridge, St. John's College.
Cambridge, Sidney Sussex College.
Cambridge, Trinity College.
Cambridge University Library.
Cambridge, Sedgwick Museum.
Canadian Geological Survey, Sussex Street, Ottawa, Canada.
Capetown Geological Commission, South African Museum.
Cardiff Public Library, Cardiff.
Cardiff, University College of South Wales.
Carlisle Public Library, Carlisle.
Chelsea Public Library, Manresa Road. S.W.
Cheltenham College, Cheltenham.
Cheltenham Natural Science Society, Cheltenham.

Chester Society of Natural Science, Chester.
Chicago (U.S.A.), Newberry Library.
Chicago (U.S.A.) Public Library.
Chiswick Public Library, Chiswick. W.
Christ Church Public Library, Blackfriars Road, Southwark. S.E.
Christiania (Norway), University Library.
Cincinnati (U.S.A.) Public Library.
Clarke, Mrs. Stephenson, Brooke House, Haywards Heath, Sussex.
Clermont-Ferrand (France), University Library.
Clifton College, Clifton, Bristol.
Clough, C. T., Esq., F.G.S., 28, Jermyn Street. S.W.
Coates, Henry, Esq., F.L.S., Pitcullen House, Perth.
Cobbold, E. S., Esq., F.G.S., Church Stretton, R.S.O., Shropshire.
Coomaraswamy, A. K., Esq., B.Sc., F.L.S., F.G.S., Walden, Worplesdon, Guildford.
Coombs, J. Ashton, Esq., F.G.S., Albion Lodge, Gloucester Road, Cheltenham.
Cork, Queen's College.
Cornell University, Ithaca, U.S.A.
Coventry Free Public Library, Coventry.
Crosfield, Miss Margaret, Undercroft, Reigate.
Croydon Free Library, Croydon.
Cullis, Prof. C. Gilbert, D.Sc., F.G.S., Royal College of Science, South Kensington. S.W.

Darwin, W. E., Esq., F.G.S., 11, Egerton Place. S.W.
Davis, Prof. J. R. Ainsworth, M.A., University College, Aberystwyth.
Dawkins, Prof. W. Boyd, D.Sc., F.R.S., F.G.S., Fallowfield House, Fallowfield, Manchester.
Deane, Henry, Esq., F.L.S., Equitable Building, First Floor, George Street, Sydney, N.S.W.
Delgado, Senhor J. F. N., Direccao dos Trabalhos geologicos, 113, Rua do Arco a Jesus, Lisbon.
Derby Free Library and Museum, Derby.
Derham, Walter, Esq., 76, Lancaster Gate, Bayswater. W.
Devonport Free Public Library, Devonport.
Devonshire, His Grace the Duke of, K.G., F.R.S., Devonshire House, Piccadilly. W.
Dewsbury Public Free Library, Dewsbury.
Dickinson, W., Esq., F.G.S., Warham Road, Croydon.
Dickson, Edward, Esq., F.G.S., 17, Winckley Street, Preston.
Dijon (France), University Library.
Dixon, E., Esq., F.G.S., Museum of Practical Geology, Jermyn Street. S.W.
Donald, Miss, Quarry Hill, near Mealsgate, *viâ* Carlisle.
Doncaster Borough Free Library, Doncaster.
Dorset County Museum Library, Dorchester.
Dowson, E. T., Esq., F.R.M.S., Geldeston, Beccles.
Drake, Henry C., Esq., 45, Witham, Hull.
Drew, Dr. J., F.G.S., Montrose, Battledown, Cheltenham.
Dublin, National Library.
Dublin, Royal College of Science for Ireland, Stephen's Green.
Dublin, Royal Irish Academy, 19, Dawson Street.

Dublin, Trinity College.
Ducie, Right Hon. Earl of, F.R.S., Tortworth Court, Gloucestershire.
Dudley and Midland Geological and Scientific Society and Field Club.
Dundee Free Library, Dundee.
Durham, the Dean and Chapter of (by C. Rowlandson, Esq., The College, Durham).

Edinburgh Geological Society, India Buildings, George IV Bridge, Edinburgh.
Edinburgh, Royal Scottish Museum, Argyle Square, Edinburgh.
Edinburgh Public Library, Edinburgh.
Edinburgh, Royal Society of.
Edinburgh, University of.
Epsom College, Epsom.
Eton College, Windsor, *per* M. D. Hill, Esq., M.A.
Evans, Sir John, K.C.B., D.C.L., F.R.S., F.G.S., Nash Mills, Hemel Hempstead.
Exeter, Royal Albert Memorial Public Library, Queen Street.

Folkestone Public Library and Museum, Folkestone.
Foord, Dr. A. H., F.G.S., Royal Dublin Society, Dublin.
Fortey, Charles, Esq., Abbey Villa, Ludlow.
Foulerton, Dr. J., 44, Pembridge Villas, Bayswater. W.
Fox, Howard, Esq., F.G.S., Falmouth.
Fraser, John, Esq., M.A., M.D., F.R.C.S.Edin., F.G.S., Chapel Ash, Wolverhampton.
Friedländer, Messrs., *Local Secretaries*, 11, Carlstrasse, Berlin.
Fuller, Rev. A., M.A., The Lodge, 7, Sydenham Hill. S.E.

Galashiels, N.B., Public Library.
Galway, Queen's College.
Garwood, Prof. E. J., M.A., F.G.S., University College, Gower Street. W.C.
Gascoigne, Major Trench, Lotherton Hall, Aberford, Leeds.
Gateshead-on-Tyne Public Library, Gateshead-on-Tyne.
Gaudry, Prof., Membre de l'Institut, F.M.G.S., Muséum d'Histoire Naturelle, Paris.
Geikie, Sir Archibald, LL.D., Sec.R.S., 3, Sloane Court. S.W.
Gibson, Miss, Hill House, Saffron Walden.
Gillett Geological Trust, Street, Somerset.
Gilmour, M., Esq., F.Z.S., Saffronhall House, 1, Windmill Road, Hamilton. N.B.
Glasgow, Geological Society, 150, Hope Street.
Glasgow, Mitchell Library, 21, Miller Street.
Glasgow, Royal Philosophical Society, 207, Bath Street.
Glasgow Public Museum, Kelvingrove.
Glasgow, University of.
Gloucester Free Public Library.
Gosselet, Prof. J., 159, Rue Brûle-Maison, Lille, France.
Great Yarmouth Public Library.
Green, Upfield, Esq., F.G.S., 8, Bramshill Road, Harlesden. N.W.
Greenly, Edward, Esq., F.G.S., Achnashean, near Bangor.
Gregory, Prof. J. W., D.Sc., F.R.S., The University, Glasgow.

Haileybury College, near Hertford.
Halifax Free Public Library, Halifax.
Hamilton, R. H., Esq., 9, Sunnyside Villas, Canterbury Road, Leyton. N.E.
Hammersmith Free Public Library, Ravenscourt Park, Hammersmith. W.
Hampstead Public Library, Finchley Road, Hampstead. N.W.
Handsworth Public Library, Birmingham.
Hannah, R., Esq., F.G.S., 82, Addison Road, Kensington. W.
Harker, Alfred, Esq., M.A., F.R.S., St. John's College, Cambridge.
Harley, Dr. John, F.L.S., Beedings, Pulborough, Sussex.
Harmer, F. W., Esq., F.G.S., Oakland House, Cringleford, near Norwich.
Hawick Public Library, Hawick. N.B.
Heidelberg (Germany), University Library.
Hereford Public Library.
Hill, Rev. Edwin, M.A., F.G.S., The Rectory, Cockfield, Bury St. Edmunds.
Hill, Wm., Esq., F.G.S., The Maples, Hitchin.
Hind, Wheelton, Esq., M.D.Lond., F.R.C.S., F.G.S., Roxeth House, Stoke-on-Trent.
Hinde, Geo. J., Esq., Ph.D., F.R.S., *Treasurer* and *Vice-President*, 24, Avondale Road, South Croydon.
Hodges, Figgis, and Co., 104, Grafton Street, Dublin.
Holcroft, Sir Charles, The Shrubbery, Summerhill, Kingswinford, near Dudley.
Hooley, R. W., Esq., F.G.S., Ashton Lodge, Portswood, Southampton.
Hopkinson, John, Esq., F.L.S., F.G.S., *Local Secretary*, Weetwood, Watford.
Hove Public Library, Hove, Brighton.
Howe, J. Allen, Esq., F.G.S., Museum of Practical Geology, Jermyn Street. S.W.
Howse, Sir H. G., M.S., F.R.C.S., The Tower House, Cudham, near Sevenoaks, Kent.
Hudleston, W. H., Esq., F.R.S., F.G.S., *Vice-President*, 8, Stanhope Gardens. S.W.
Hughes, Prof. T. M'K., M.A., F.R.S., Sedgwick Museum, Cambridge.
Hull Public Library, Hull.
Hutchinson, Rev. H. N., F.G.S., 94, Fellowes Road, Hampstead. N.W.
Hutton, Miss Mary, Harescombe Grange, Stroud, Gloucestershire.

India, Geological Survey of, Calcutta.
Ipswich Museum, Ipswich. (F. Woolnough, Esq., Secretary.)
Isle of Man Natural History Society, Ramsey, Isle of Man.

Johnes, Mrs., and Lady E. Hills, Dolau Cothy, Llandeilo, R.S.O., South Wales.
Johns Hopkins University, Baltimore, U.S.A.
Johnson, E., Esq., 69, Bickenhall Mansions, Gloucester Place. W.
Jukes-Browne, A. J., Esq., B.A., F.G.S., Floriston, Cleveland Road, Torquay.
Kettering Public Library, Kettering.
Kilmarnock Public Library, Kilmarnock. N.B.
Kirkby, Richard, Esq., Lindisfarne, Leven, Fife.
Kirkcaldy Naturalists' Society; David Kinloch, Esq., Hon. Sec., 3, Little Lane, High Street, Kirkcaldy. N.B.
Kitchin, F. L., Esq., M.A., Ph.D., F.G.S., Geol. Survey of England, 28, Jermyn Street. S.W.
Knipe, H. R., Esq., 9, Linden Park, Tunbridge Wells.

Lake, P., Esq., M.A., F.G.S., St. John's College, Cambridge.
Lancaster Public Library, Lancaster.
Lang, W. D., Esq., M.A., British Museum (Nat. Hist.), South Kensington. S.W.
Lapworth, Prof. Charles, LL.D., F.R.S., University of Birmingham.
Lausanne (Switzerland), Musée Géologique.
Leeds Philosophical and Literary Society, Leeds.
Leeds Public Library, Leeds.
Leeds University.
Leek, Staffordshire, Nicholson Institute.
Leicester Town Museum, Leicester.
Leighton, T., Esq., F.G.S., 16, New Street Square, Fleet Street. E.C.
Leipzig (Germany), University Library.
Leyton Public Library, Leyton. N.E.
Liège (Belgium), University Library.
Lissajous, Mons. M., 10, Quai des Marans, Mâcon, France.
Liveing, Professor G. D., M.A., F.R.S., Cambridge.
Liverpool, Athenæum Library.
Liverpool, Free Public Library.
Liverpool, Geological Society of.
Lomas, Joseph, Esq., F.G.S., *Local Secretary*, 13, Moss Grove, Birkenhead.
London, Board of Education, Science Library, South Kensington. S.W.
London, British Museum, Bloomsbury. W.C.
London, British Museum (Nat. Hist.), Cromwell Road. S.W.
London, Corporation of, Library Committee of, Guildhall. E.C.
London, Geological Society, Burlington House. W.
London, Geologists' Association, University College. W.C.
London Institution, Finsbury Circus. E.C.
London, King's College, Strand, W.C.
London, Linnean Society, Burlington House, Piccadilly. W.
London, Museum of Practical Geology, Jermyn Street. S.W.
London, Royal College of Surgeons, Lincoln's Inn Fields. W.C.
London, Royal Institution of Great Britain, Albemarle Street. W.
London, Royal Society of, Burlington House. W.
London, St. Martin's-in-the-Fields Public Library, 115, St. Martin's Lane. W.C.
London, University College, Gower Street. W.C.
London, Zoological Society, 3, Hanover Square. W.
Loughborough Free Public Library, Loughborough.
Lydekker, Richard, Esq., F.R.S., The Lodge, Harpenden, Herts.

Mackenzie, G. W., Esq., 13, William Street, Lowndes Square. S.W.
McNeill, Bedford, Esq., F.G.S., 29, North Villas, Camden Square. N.W.
McPherson, William, Esq., F.G.S., 3, Manilla Road, Clifton, Bristol.
Madras Government Museum, *per* Messrs. Baker and Co., 6, Bond Court, Walbrook. E.C.
Maidstone Museum, *per* Brenchley Trustees, Maidstone.
Major, Charles H., Esq., Cromwell House, Croydon.
Malton Field Naturalists' and Scientific Society, Malton, Yorkshire.
Manchester Free Library.
Manchester, Geological Society of, 5, John Dalton Street, Manchester.

Manchester Literary and Philosophical Society, 36, George Street, Manchester.
Marburg (Germany), University of.
Marr, J. E., Esq., M.A., Sc.D., F.R.S., St. John's College, Cambridge.
Melbourne Public Library.
Mennell, H. T., Esq., F.L.S., The Red House, Croydon.
Metcalfe, Henry F., Esq., Fairfield, Great Malvern, and Cyprus House, Exmouth.
Middlesbrough Free Library.
Middleton Free Public Library, Middleton, near Manchester.
Mitchinson, Rt. Rev. J., D.C.L., D.D., Canon of Gloucester and Master of Pembroke College, Oxford.
Mond, Robert, Esq., M.A., F.R.S.E., F.G.S., 27, Berkeley Square. W.
Munich (Germany), Alte Akademie, Geologisches Museum.
Munich Royal Library.

Nantwich Public Library.
New South Wales, Royal Society of, Sydney.
New York (U.S.A.) Public Library.
Newcastle-on-Tyne, Armstrong College.
Newcastle-on-Tyne, Literary and Philosophical Society of, Westgate Street, Newcastle-on-Tyne.
Newcastle-on-Tyne Public Library.
Newington Public Library, Walworth Road. S.E.
Newport Free Library, Newport, Monmouthshire.
Newton, E. T., Esq., F.R.S., *Vice-President,* Florence House, Willow Bridge Road, Canonbury. N.
Norfolk and Norwich Library, Norwich.
North Devon Athenæum, Barnstaple.
North Staffordshire Field Club, Stoke, Staffordshire.
Northampton Natural History Society, Northampton.
Northumberland, His Grace the Duke of, K.G., F.R.S., Alnwick Castle.
Norwich Free Library.
Nottingham Free Library.

Oke, Alfred W., Esq., F.G.S., 32, Denmark Villas, Hove.
Oldham Free Public Library.
Oswestry Free Public Library.
Oxford, Bodleian Library.
Oxford, Radcliffe Library.

Paisley Philosophical Institution.
Paris, École des Mines.
Paris, Geological Society of France, 7, Rue des Grands Augustins.
Paris, Muséum d'Histoire Naturelle.
Paris, Sorbonne Laboratoire de Géologie.
Parkinson, J., Esq., F.G.S., 30, Lensfield Road, Cambridge.
Peabody Institute, Salem, Mass., U.S.A.
Penton, Edw., Esq., F.G.S., 1, Mortimer Street. W.

Penzance, Royal Geological Society of Cornwall.
Peterborough Natural History, Scientific, and Archæological Society.
Philadelphia (U.S.A.), Academy of Natural Sciences.
Plymouth Free Library.
Plymouth Institution, Library of, Athenæum, Plymouth.
Poole Free Library.
Portis, Dr. A., Professor of Geology, The University, Rome.
Portsmouth Free Public Library.
Postlethwaite, J., Esq., F.G.S., Keswick.
Power, Edward, Esq., F.G.S., 16, Southwell Gardens, South Kensington. S.W.
Power, Edward John, Esq., F.G.S., 25, Ashburn Place, South Kensington. S.W.
Prague (Bohemia), Royal Geological Institution of the German Carl Ferdinand University.
Preston Free Library.
Price, F. G. H., Esq., F.G.S., 17, Collingham Gardens, South Kensington. S.W.
Pryor, M. R., Esq., Weston Manor, Stevenage, Herts.

Queensland Museum, Brisbane.

Rastall, R. H., Esq., B.A., Christ's College, Cambridge.
Reading Public Library and Museum, W. H. Greenhough, Librarian, Reading.
Reed, F. R. Cowper, Esq., M.A., F.G.S., Gaultier, Madingley Road, Cambridge.
Reid, Clement, Esq., F.R.S., 7, St. James's Mansions, West End Lane. N.W.
Rennes (France), University Library.
Reynolds, Prof. S. H., M.A., F.G.S., University College, Bristol.
Richardson, L., Esq., F.G.S., *Local Secretary*, 10, Oxford Parade, Cheltenham.
Ripon, Marquis of, K.G., 9, Chelsea Embankment. S.W.
Rochdale Free Public Library.
Roscoe, Philip, Esq., 28, Denning Road, Hampstead. N.W.
Rowe, A. W., Esq., M.S., M.B., F.G.S., 1, Cecil Street, Margate.
Rudler, F. W., Esq., I.S.O., F.G.S., 18, St. George's Road, Kilburn. N.W.
Rugby Public Library.
Rugby School Natural History Society.

St. Albans Public Library.
St. Andrews University Library.
St. Helens Free Public Library, The Gamble Institute, St. Helens.
Salford Borough Royal Museum and Library, Peel Park, Manchester.
Salisbury Free Library.
Saunders, James Ebenezer, Esq., F.L.S., F.G.S., 4, Coleman Street. E.C.
Scarborough Philosophical Society.
Scharff, R. F., Esq., Ph.D., National Museum, Dublin.
Schmidt, Dr. Martin, Büchsenstrasse 56, Stuttgart.
Scott, D. H., Esq., M.A., Ph.D., F.R.S., East Oakley House, Oakley, Hants.
Semple, Dr. Andrew, F.R.S.E., Caledonian United Service Club, Edinburgh.
Sheffield Free Public Library.
Sheffield, Literary and Philosophical Society of.

Sheffield, Weston Park Public Museum.
Sherborne, King's School, Library of.
Shrewsbury Free Library.
Simpkin, Marshall, and Co., Messrs., Stationers' Hall Court. E.C.
Simpson, Rev. A., B.A., B.Sc., F.G.S., 28, Myrtle Park, Crosshill, Glasgow.
Smith, Mrs. Emma, Hencotes House, Hexham.
Sollas, Professor W. J., D.Sc., F.R.S., *Local Secretary*, 173, Woodstock Road, Oxford.
Somersetshire Archæological and Natural History Society, Museum, Taunton.
Sophia, University of.
South Shields Free Public Library.
Southport Free Library.
Spencer, W. K., Esq., B.A., 198, Clive Road, West Dulwich. S.E.
Stanley, W. F., Esq., F.G.S., Cumberlow, South Norwood. S.E.
Stebbing, W. P. D., Esq., F.G.S., 8, Playfair Mansions, Queen's Club Gardens. W.
Stechert, G. E., Esq., 2, Star Yard, Carey Street, Chancery Lane. W.C.
Stirrup, Mark, Esq., F.G.S., High Thorn, Stamford Road, Bowdon, Cheshire.
Stockholm, Royal Swedish Academy of Sciences.
Stoke Newington Public Library, Church Street, Stoke Newington. N.
Stoke-upon-Trent Free Library, Stoke-upon-Trent.
Stonyhurst College, Blackburn.
Strahan, A., Esq., M.A., F.R.S., Geological Survey Office, 28, Jermyn Street. S.W.
Strangways, C. Fox, Esq., F.G.S., 28, Jermyn Street. S.W.
Strickland, Sir C. W., Bart., Hildeney, Malton.
Sunderland Corporation Museum.
Sunderland Subscription Library, Fawcett Street, Sunderland.
Swansea Public Library.
Swansea, Royal Institution of South Wales.
Sydney, New South Wales, University of.
Sydney, New South Wales, Australian Museum.

Tasmania, Royal Society of.
Toronto University.
Torquay Natural History Society, Museum, Babbacombe Road, Torquay.
Toulouse University Library.
Traquair, R. H., Esq., M.D., LL.D., F.R.S., The Bush, Colinton, Midlothian.
Truro, Royal Institution of Cornwall.
Tübingen (Germany) University Library.

Upsala (Sweden) University Library.

Vassall, H., Esq., M.A., F.G.S., Repton School, Burton-on-Trent.
Vienna, Royal Natural History Court Museum.

Walker, B. E., Esq., Canadian Bank of Commerce, Toronto, Canada.
Wandsworth Public Library, West Hill, Wandsworth. S.W.

Ward, Mrs. Henry, Rodbaston, Penkridge, Staffordshire.
Wardle, Sir Thomas, F.G.S., St. Edward Street, Leek.
Warren, S. Hazzledine, Esq., F.G.S., Sherwood, Loughton, Essex.
Warrington Museum and Library.
Warwickshire Natural History and Archæological Society, the Museum, Warwick.
Washington, U.S. Geological Survey.
Watson, Rev. R. Boog, B.A., F.R.S.E., 11, Strathearn Place, Edinburgh.
Watts, Professor W. W., M.A., F.R.S., Royal College of Science, South Kensington. S.W.
Weg, Max, 1, Leplaystrasse, Leipzig, Germany.
West Ham Public Library. E.
West Hartlepool Public Library.
Whidborne, Rev. G. F., M.A., F.G.S., Hammerwood, East Grinstead.
Whitby Literary and Philosophical Society, Museum, Whitby.
Whitechapel Free Public Library, 77, High Street, Whitechapel. E.
Wiltshire Archæological and Natural History Society, Devizes.
Winchester College Natural History Society, Winchester.
Winwood, Rev. Henry H., M.A., F.G.S., *Local Secretary*, 11, Cavendish Crescent, Bath.
Wolverhampton Free Library.
Wood Green Public Library, Wood Green.
Wood, J. G., Esq., M.A., LL.B., F.G.S., 7, New Square, Lincoln's Inn. W.C.
Woods, H., Esq., M.A., F.G.S., *Local Secretary*, St. John's College, Cambridge.
Woodward, A. Smith, Esq., LL.D., F.R.S., *Secretary*, British Museum (Nat. Hist.), South Kensington. S.W.
Woodward, Henry, Esq., LL.D., F.R.S., *President*, 129, Beaufort Street, Chelsea. S.W.
Worcester Public Library and Hastings Museum, Worcester.
Workington Public Library, Workington, Cumberland.
Wright, Joseph, Esq., F.G.S., 4, Alfred Street, Belfast.
Würzburg (Germany) University Library.

Yorkshire Philosophical Society, Museum, York.
Young, George W., Esq., F.G.S., 34, Glenthorne Road, Hammersmith. W.
Yule, Miss A. F., Tarradale House, by Muir-of-Ord, Ross-shire. N.B.

CATALOGUE OF THE CONTENTS OF THE ANNUAL VOLUMES

ALREADY PUBLISHED BY

THE PALÆONTOGRAPHICAL SOCIETY.

Vol. I.	Issued March, 1848, for the Year 1847	The Crag Mollusca, Part I, Univalves, by Mr. S. V. Wood (pp. i—xii, 1—208, pls. i—xxi, and title-page).
„ II.	Issued July, 1849, for the year 1848	The Reptilia of the London Clay, Vol. I, Part I, Chelonia, &c., by Profs. Owen and Bell (pp. 1—76, pls. i—xxviii, viii A, x A, xiii A, xvi A, xviii A, xix*, xix B, xix C, xix D).
		The Eocene Mollusca, Part I, Cephalopoda, by Mr. F. E. Edwards (pp. 1—56, pls. i—ix).
„ III.[1]	Issued Aug., 1850, for the Year 1849	The Entomostraca of the Cretaceous Formations, by Mr. T. R. Jones (pp. 1—40, pls. i—vii).
		The Permian Fossils, by Prof. Wm. King (pp. i—xxxviii, 1—258, pls. i—xxviii*).
		The Reptilia of the London Clay, Vol. I, Part II, Crocodilia and Ophidia, &c., by Prof. Owen (pp. 1—68, pls. xxix, i—xvi, ii A).
		The Fossil Corals, Part I, Crag, London Clay, Cretaceous, by Messrs. Milne Edwards and Jules Haime (pp. i—lxxxv, 1—72, pls. i—xi).
„ IV.	Issued June, 1851, for the Year 1850	The Crag Mollusca, Part II, No. 1, by Mr. S. V. Wood (pp. 1—150, pls. i—xii).
		The Mollusca of the Great Oolite, Part I, Univalves, by Messrs. Morris and Lycett (pp. i—viii, 1—130, pls. i—xv).
		The Fossil Brachiopoda, Vol. I, Part III, No. 1, Oolitic and Liassic, by Mr. Davidson (pp. 1—64, pls. i—xiii).
„ V.	Issued June, 1851, for the Year 1851	The Reptilia of the Cretaceous Formations, by Prof. Owen (pp. 1—118, pls. i—xxxvii, vii A, ix A).
		The Fossil Corals, Part II, Oolitic, by Messrs. Milne Edwards and Jules Haime (pp. 73—146, pls. xii—xxx).
		The Fossil Lepadidæ, by Mr. Charles Darwin (pp. i—vi, 1—88, pls. i—v).
„ VI.	Issued Aug., 1852, for the Year 1852	The Fossil Corals, Part III, Permian and Mountain-limestone, by Messrs. Milne Edwards and Jules Haime (pp. 147—210, pls. xxxi—xlvi).
		The Fossil Brachiopoda, Vol. I, Part I, Tertiary, by Mr. Davidson (pp. 1—23, pls. i, ii).
		The Fossil Brachiopoda, Vol. I, Part II, No. 1, Cretaceous, by Mr. Davidson (pp. 1—54, pls. i—v).
		The Fossil Brachiopoda, Vol. I, Part III, No. 2, Oolitic, by Mr. Davidson (pp. 65—100, pls. xiv—xviii).
		The Eocene Mollusca, Part II, Pulmonata, by Mr. F. E. Edwards (pp. 57—122, pls. x—xv).
		The Echinoderms of the Crag, London Clay, &c., by Prof. E. Forbes (pp. i—viii, 1—36, pls. i—iv, and title-page).
„ VII.	Issued Dec., 1853, for the Year 1853	The Fossil Corals, Part IV, Devonian, by Messrs. Milne Edwards and Jules Haime (pp. 211—244, pls. xlvii—lvi).
		The Fossil Brachiopoda, Introduction to Vol. I, by Mr. Davidson (pp. 1—136, pls. i—ix).
		The Mollusca of the Chalk, Part I, Cephalopoda, by Mr. D. Sharpe (pp. 1—26, pls. i—x).
		The Mollusca of the Great Oolite, Part II, Bivalves, by Messrs. Morris and Lycett (pp. 1—80, pls. i—viii).
		The Mollusca of the Crag, Part II, No. 2, Bivalves, by Mr. S. V. Wood (pp. 151—216, pls. xiii—xx)
		The Reptilia of the Wealden Formations, Part I, Chelonia, by Prof. Owen (pp. 1—12, pls. i—ix).

[1] The Volume for the year 1849 consists of two separate portions, each of which is stitched in a paper cover, on which are printed the dates 1848, 1849, and 1850. The one portion contains 'Cretaceous Entomostraca' and 'Permian Fossils;' the other, 'London Clay Reptilia,' Part II, and 'Fossil Corals,' Part I.

CATALOGUE OF VOLUMES—Continued.

Vol. VIII.[1] Issued May, 1855, for the Year 1854	The Fossil Brachiopoda, Vol. I, Part II, No. 2, Cretaceous (pp. 55—117, pls. vi—xii), with Appendix and Index to Vol. I, by Mr. Davidson (pp. 1—30, pl. A). The Reptilia of the Wealden Formations, Part II, Dinosauria, by Prof. Owen (pp 1—54, pls. i—xix, xvi A). The Mollusca of the Great Oolite, Part III, Bivalves, by Messrs. Morris and Lycett (pp. 81—147, pls. ix—xv). The Fossil Corals, Part V, Silurian, by Messrs. Milne Edwards and Jules Haime (pp. 245—322, pls. lvii—lxxii). The Fossil Balanidæ and Verrucidæ, by Mr. Charles Darwin (pp. 1—44, pls. i, ii). The Mollusca of the Chalk, Part II, Cephalopoda, by Mr. D. Sharpe (pp. 27—36, pls. xi—xvi). The Eocene Mollusca, Part III, No. 1, Prosobranchiata, by Mr. F. E. Edwards (pp. 123—180, pls. xvi—xxiii).
„ IX.[2] Issued Feb., 1857, for the Year 1855	The Mollusca of the Crag, Part II, No. 3, Bivalves, by Mr. S. V. Wood (pp. 217—342, pls. xxi—xxxi). The Reptilia of the Wealden Formations, Part III, by Prof. Owen (pp. 1—26, pls. i—xii). The Eocene Mollusca, Part III, No. 2, Prosobranchiata, continued, by Mr. F. E. Edwards (pp. 181—240, pls. xxiv—xxvii). The Mollusca of the Chalk, Part III, Cephalopoda, by Mr. D. Sharpe (pp. 37—68, pls. xvii—xxvii). The Tertiary Entomostraca, by Mr. T. R. Jones (pp. i—xii, 1—68, pls. i—vi). The Fossil Echinodermata, Oolitic, Vol. I, Part I, by Dr. Wright (pp. v—x, 1—154, pls. i—x).
„ X. Issued April, 1858, for the Year 1856	The Fossil Echinodermata, Oolitic, Vol. I, Part II, by Dr. Wright (pp. 155—302, pls. xi—xxii). The Fossil Crustacea, Part I, London Clay, by Prof. Bell (pp. i—viii, 1—44, pls. i—xi). The Fossil Brachiopoda, Vol. II, Part IV, Permian, by Mr. Davidson (pp. 1—51, pls. i—iv). The Fossil Brachiopoda, Vol. II, Part V, No. 1, Carboniferous, by Mr. Davidson (pp. 1—48, pls. i—viii). The Reptilia of the Wealden Formations, by Prof. Owen, Part IV (pp. 8—26, pls. iv—xi), and Supplement No. 1 (pp. 1—7, pls. i—iii). The Reptilia of the London Clay, Vol. I (Supplement), by Prof. Owen (pp. 77—79. pls. xxviii A, xxviii B).
„ XI. Issued Nov., 1859. for the Year 1857	The Fossil Echinodermata, Oolitic, Vol. I, Part III, by Dr. Wright (pp. 303—390, pls. xxiii—xxxvi). The Fossil Brachiopoda, Vol. II, Part V, No. 2, Carboniferous, by Mr. Davidson (pp. 49—80. pls. ix—xvi). The Reptilia of the Cretaceous Formations (Supplement No. 1), by Prof. Owen (pp. 1—19, pls. i—iv). The Reptilia of the Wealden Formations (Supplement No. 2), by Prof. Owen (pp. 20—44, pls. v—xii.) The Polyzoa of the Crag, by Prof. Busk (pp. i—xiv, 1—136, pls. i—xxii).
„ XII. Issued March, 1861, for the Year 1858	The Fossil Echinodermata, Oolitic, Vol. I, Part IV, by Dr. Wright (pp. 391—468, pls. xxxvii—xliii). The Eocene Mollusca, Part III, No. 3, Prosobranchiata continued, by Mr. F. E Edwards (pp. 241—330, pls. xxviii—xxxiii). The Reptilia of the Cretaceous Formations (Supplements No. 2, No. 3), by Prof. Owen (pp. 27—30 pl. vii, pp. 1—25, pls. i—vi). The Reptilia of the Purbeck Limestones, by Prof. Owen (pp. 31—39, pl. viii). The Fossil Brachiopoda, Vol. II, Part V, No. 3, Carboniferous by Mr. Davidson (pp 81—120, pls. xvii—xxvi).
„ XIII. Issued Dec., 1861, for the Year 1859	The Fossil Brachiopoda, Part V, No. 4, Carboniferous, by Mr. Davidson (pp. 121—210, pls. xxvii—xlvii). The Reptilia of the Oolitic Formations, No. 1, Lower Lias, by Prof. Owen (pp. 1—14, pls. i—vi). The Reptilia of the Kimmeridge Clay, No. 1, by Prof. Owen (pp. 15, 16, pl. vii). The Eocene Mollusca, Part IV, No. 1, Bivalves, by Mr. S. V. Wood (pp. 1—74, pls i—xiii).

[1] This Volume is marked on the outside 1855.
[2] This Volume is marked on the outside 1856.

CATALOGUE OF VOLUMES—Continued.

Vol. XIV. Issued May, 1863, for the Year 1860	The Fossil Brachiopoda, Vol. II, Part V, No. 5, Carboniferous, by Mr. Davidson (pp. 211—280, pls. xlviii—lv). The Reptilia of the Oolitic Formations, No. 2, Lower Lias, by Prof. Owen (pp. 1—26, pls. i—xi). The Reptilia of the Kimmeridge Clay, No. 2, by Prof. Owen (pp. 27, 28, pl. xii). The Fossil Estheriæ, by Prof. Rupert Jones (pp. i—x, 1—134, pls. i—v). The Fossil Crustacea, Part II, Gault and Greensand, by Prof. Bell (pp. i—vii, 1—40, pls. i—xi).
„ XV. Issued May, 1863, for the Year 1861	The Fossil Echinodermata, Oolitic, Vol. II, Part I (Asteroidea), by Dr. Wright (pp. 1—130, pls. i—x, x A, xi, xii). Supplement to the Great Oolite Mollusca, by Dr. Lycett (pp. 1—129, pls. xxxi—xlv).
„ XVI. Issued Aug., 1864, for the Year 1862	The Fossil Echinodermata, Cretaceous, Vol. I, Part I, by Dr. Wright (pp. 1—64, pls. i—iii, iii A, iv—vii, vii A, viii, xi). The Trilobites of the Silurian, Devonian, &c., Formations, Part I (Devonian and Silurian), by Mr. J. W. Salter (pp. 1—80, pls. i—vi). The Fossil Brachiopoda, Vol. III, Part VI, No. 1, Devonian, by Mr. Davidson (pp. 1—56, pls. i—ix). The Eocene Mollusca, Part IV, No. 2, Bivalves, by Mr. S. V. Wood (pp. 75—136, pls. xiv—xx). The Reptilia of the Cretaceous and Wealden Formations (Supplement, No. 4), by Prof. Owen (pp. 1—18, pls. i—ix).
„ XVII. Issued June, 1865, for the Year 1863	The Trilobites of the Silurian, Devonian, &c., Formations, Part II, by Mr. J. W. Salter (pp. 81—128, pls. vii—xiv). The Fossil Brachiopoda, Vol. III, Part VI, No. 2, Devonian, by Mr. Davidson (pp. 57—131, pls. x—xx). The Belemnitidæ, Part I, Introduction, by Prof. Phillips (pp. 1—28). The Reptilia of the Liassic Formations, Part I, by Prof. Owen (pp. 1—40, pls. i—xvi).
„ XVIII. Issued April, 1866, for the Year 1864	The Fossil Echinodermata, Oolitic, Vol. II, Part II (Liassic Ophiuroidea), by Dr. Wright (131—154, pls. xiii—xviii). The Trilobites of the Silurian, Devonian, &c., Formations, Part III, by Mr. J. W. Salter (pp. 129—176, pls. xv—xxv). The Belemnitidæ, Part II, Liassic Belemnites, by Prof. Phillips (pp. 29—52, pls. i—vii). The Pleistocene Mammalia, Part I, Introduction, Felis spelæa, by Messrs. W. Boyd Dawkins and W. A. Sanford (pp. i—l, 1—28, pls. i—v). Title-pages, &c., to the Monographs on the Reptilia of the London Clay, Cretaceous, and Wealden Formations.
„ XIX.[1] Issued Dec., 1866, for the Year 1865	The Crag Foraminifera, Part I, by Messrs. T. Rupert Jones, W. K. Parker, and H. B. Brady (pp. i—vi, 1—72, pls. i—iv). Supplement to the Fossil Corals, Part I, Tertiary, by Dr. Duncan (pp. i—iii, 1—66, pls. i—x). The Fossil Merostomata, Part I, Pterygotus, by Mr. H. Woodward (pp. 1—44, pls. i—ix). The Fossil Brachiopoda, Vol. III, Part VII, No. 1, Silurian, by Mr. Davidson (pp. 1—88, pls. i—xii).
„ XX. Issued June, 1867, for the Year 1866	Supplement to the Fossil Corals, Part IV, No. 1, Liassic, by Dr. Duncan (pp. i—iii, 1—44, pls. i—xi). The Trilobites of the Silurian, Devonian, &c., Formations, Part IV (Silurian), by Mr. J. W. Salter (pp. 177—214, pls. xxv*—xxx). The Fossil Brachiopoda, Vol. III, Part VII, No. 2, Silurian, by Mr. Davidson (pp. 89—168, pls. xiii—xxii). The Belemnitidæ, Part III, Liassic Belemnites, by Prof. Phillips (pp. 53—88, pls. viii—xx).
„ XXI. Issued June, 1868, for the Year 1867	Flora of the Carboniferous Strata, Part I, by Mr. E. W. Binney (pp. 1—32, pls. i—vi). Supplement to the Fossil Corals, Part IV, No. 2, Liassic, by Dr. Duncan (pp. 45—73, pls. xii—xvii). The Fossil Echinodermata, Cretaceous, Vol. I, Part II, by Dr. Wright (pp. 65—112, pls. ix, x, xii—xxi, xxi A, xxi B). The Fishes of the Old Red Sandstone, Part I, by Messrs. J. Powrie and E. Ray Lankester (pp. 1—32, pls. i—v). The Pleistocene Mammalia, Part II, Felis spelæa, continued, by Messrs. W. Boyd Dawkins and W. A. Sanford (pp. 29—124, pls. vi—xix).

[1] From 1865 onwards the Volumes are issued in two forms of binding: first, with all the Monographs stitched together and enclosed in one cover; secondly, with each of the Monographs separate, and the whole of the separate parts placed in an envelope. The previous Volumes are not in separate parts.

CATALOGUE OF VOLUMES—Continued.

Vol. XXII. Issued Feb., 1869, for the Year 1868

- Supplement to the Fossil Corals, Part II, No. 1, Cretaceous, by Dr. Duncan (pp. 1—26, pls. i—ix)
- The Fossil Merostomata, Part II, Pterygotus, by Mr. H. Woodward (pp. 45—70, pls. x—xv).
- The Fossil Brachiopoda, Vol. III, Part VII, No. 3, Silurian, by Mr. Davidson (pp. 169—248, pls. xxiii—xxxvii).
- The Belemnitidæ, Part IV, Liassic and Oolitic Belemnites, by Prof. Phillips (pp. 89—108, pls. xxi—xxvii).
- The Reptilia of the Kimmeridge Clay, No. 3, by Prof. Owen (pp. 1—12, pls. i—iv).
- The Pleistocene Mammalia, Part III, Felis spelæa, concluded, with F. lynx, by Messrs. W. Boyd Dawkins and W. A. Sanford (pp. 125—176, pls. xx—xxii, xxii A, xxii B, xxiii).

„ XXIII. Issued Jan., 1870, for the Year 1869

- Supplement to the Fossil Corals, Part II, No. 2, Cretaceous, by Dr. Duncan (pp. 27—46, pls. x—xv).
- The Fossil Echinodermata, Cretaceous, Vol. I, Part III, by Dr. Wright (pp. 113—136, pls. xxii—xxix, xxix A, xxix B).
- The Belemnitidæ, Part V, Oxford Clay, &c., Belemnites, by Prof. Phillips (pp. 109—128, pls. xxviii—xxxvi).
- The Fishes of the Old Red Sandstone, Part I (concluded), by Messrs. J. Powrie and E. Ray Lankester (pp. 33—62, pls. vi—xiv).
- The Reptilia of the Liassic Formations, Part II, by Prof. Owen (pp. 41—82, pls. xvii—xx).
- The Crag Cetacea, No. 1, by Prof. Owen (pp. 1—40, pls. i—v).

„ XXIV. Issued Jan., 1871, for the Year 1870

- The Flora of the Carboniferous Strata, Part II, by Mr. E. W. Binney (33—62, pls. vii—xii).
- The Fossil Echinodermata, Cretaceous, Vol. I, Part IV, by Dr. Wright (pp. 137—160, pls. xxx—xxxix).
- The Fossil Brachiopoda, Vol. III, Part VII, No. 4, Silurian, by Mr. Davidson (pp. 249—397, pls. xxxviii—l).
- The Eocene Mollusca, Part IV, No. 3, Bivalves, by Mr. S. V. Wood (pp. 137—182, pls. xxi—xxv).
- The Fossil Mammalia of the Mesozoic Formations, by Prof. Owen (pp. i—vi, 1—115, pls. i—iv).

„ XXV. Issued June, 1872, for the Year 1871

- The Flora of the Carboniferous Strata, Part III, by Mr. E. W. Binney (pp. 63—96, pls xiii—xviii).
- The Fossil Merostomata, Part III, Pterygotus and Slimonia, by Mr. H. Woodward (pp. 71—120, pls. xvi—xx).
- Supplement to the Crag Mollusca, Part I (Univalves), by Mr. S. V. Wood, with an Introduction on the Crag District, by Messrs. S. V. Wood, jun., and F. W. Harmer (pp. i—xxxi, 1—98, pls. i—vii, and map).
- Supplement to the Reptilia of the Wealden (Iguanodon), No. IV, by Prof. Owen (pp. 1—15, pls. i—iii).
- The Pleistocene Mammalia, Part IV, Felis pardus, &c., by Messrs. W. Boyd Dawkins and W. A. Sanford (pp. 177—194, pls. xxiv, xxv).
- The Pleistocene Mammalia, Part V, Ovibos moschatus, by Mr. W. Boyd Dawkins (pp. 1—30, pls. i—v).

„ XXVI. Issued Oct., 1872, for the Year 1872

- Supplement to the Fossil Corals, Part III (Oolitic), by Prof. Duncan (pp. 1—24, pls. i—vii), with an Index to the Tertiary and Secondary Species.
- The Fossil Echinodermata, Cretaceous, Vol. I, Part V, by Dr. Wright (pp. 161—184, pls. xl—xliv).
- The Fossil Merostomata, Part IV (Stylonurus, Eurypterus, Hemiaspis), by Mr. H. Woodward (pp. 121—180, pls. xxi—xxx).
- The Fossil Trigoniæ, No. I, by Dr. Lycett (pp. 1—52, pls. i—ix).

CATALOGUE OF VOLUMES—Continued.

Vol. XXVII. Issued Feb., 1874, for the Year 1873

- The Fossil Echinodermata, Cretaceous, Vol. I, Part VI, by Dr. Wright (pp. 185—224, pls. xlv—lii).
- Supplement to the Fossil Brachiopoda, Vol. IV, Part I (Tertiary and Cretaceous), by Mr. Davidson (pp. 1—72, pls. i—viii).
- Supplement to the Crag Mollusca, Part II (Bivalves), by Mr. S. V. Wood (pp. 99—231, pls. viii—xi, and add. plate).
- Supplement to the Reptilia of the Wealden (Iguanodon), No. V, by Prof. Owen (pp. 1—18, pls. i, ii).
- Supplement to the Reptilia of the Wealden (Hylæochampsa), No. VI, by Prof. Owen (pp. 1—7).
- The Fossil Reptilia of the Mesozoic Formations, Part I, by Prof. Owen (pp. 1—14, pls. i, ii).

,, XXVIII. Issued July, 1874, for the Year 1874

- The Post-Tertiary Entomostraca, by Mr. G. S. Brady, Rev. H. W. Crosskey, and Mr. D. Robertson (pp. i—v, 1—232, pls. i—xvi).
- The Carboniferous Entomostraca, Part I (Cypridinidæ), by Prof. T. Rupert Jones and Messrs. J. W. Kirkby and G. S. Brady (pp. 1—56, pls. i—v).
- The Fossil Trigoniæ, No. II, by Dr. Lycett (pp. 53—92, pls. x—xix).

,, XXIX. Issued Dec. 1875, for the Year 1875

- The Flora of the Carboniferous Strata, Part IV, by Mr. E. W. Binney (pp. 97—147, pls. xix—xxiv).
- The Fossil Echinodermata, Cretaceous, Vol. I, Part VII, by Dr. Wright (pp. 225—264. pls. liii—lxii).
- The Fossil Trigoniæ, No. III, by Dr. Lycett (pp. 93—148, pls. xx—xxvii).
- The Fossil Reptilia of the Mesozoic Formations, Part II, by Prof. Owen (pp. 15—94, pls. iii—xxii).

,, XXX. Issued Dec., 1876, for the Year 1876

- The Carboniferous and Permian Foraminifera (the genus Fusulina excepted), by Mr. H. B. Brady (pp. 1—166, pls. i—xii).
- Supplement to the Fossil Brachiopoda, Vol. IV, Part II, No. 1 (Jurassic and Triassic), by Mr. Davidson (pp. 73—144, pls. ix—xvi).
- Supplement to the Reptilia of the Wealden (Poikilopleuron and Chondrosteosaurus), No. VII, by Prof. Owen (pp. 1—7, pls. i—vi).

,, XXXI. Issued Feb., 1877, for the Year 1877

- Supplement to the Eocene Mollusca (Bivalves), by Mr. S. V. Wood, 2 plates.
- The Fossil Trigoniæ, No. IV, by Dr. Lycett (pp. 149—204, pls. xxviii—xl).
- The Eocene Mollusca (Univalves), Part IV, by Mr. S. V. Wood (pp. 331—361, pl. xxxiv).
- The Carboniferous Ganoid Fishes, Part I (Palæoniscidæ), by Dr. Traquair (pp. 1—60, pls. i—vii).
- The Fossil Reptilia of the Mesozoic Formations, Part III, by Prof. Owen (pp. 95—97, pls. xxiii, xxiv).
- The Fossil Elephants (E. antiquus), Part I, by Prof. Leith Adams (pp. 1—68, pls. i—v).

,, XXXII. Issued Mar., 1878, for the Year 1878

- The Fossil Echinodermata, Cretaceous, Vol. I, Part VIII, by Dr. Wright (pp. 265—300, pls. lxii A, lxiii—lxix).
- Index and Title Page to the Fossil Echinodermata, Oolitic, Vol. I (Echinoidea), by Dr. Wright (pp. 469—481).
- The Fossil Merostomata, Part V (Neolimulus, &c.), by Dr. H. Woodward (pp. 181—263, pls. xxxi—xxxvi, and title-page).
- Supplement to the Fossil Brachiopoda, Vol. IV, Part II, No. 2 (Jurassic and Triassic), by Mr. Davidson (pp. 145—242, pls. xvii—xxix).
- The Lias Ammonites, Part I, by Dr. Wright (pp. 1—48, pls. i—viii).
- The Sirenoid and Crossopterygian Ganoids, Part I, by Prof. Miall (pp. 1—32, pls. i, i A, ii—v).
- Supplement to the Reptilia of the Wealden (Goniopholis, Petrosuchus, and Suchosaurus), No. VIII, by Prof. Owen (pp. 1—15, pls. i—vi).
- The Pleistocene Mammalia, Part A (Preliminary Treatise), by Prof. Boyd Dawkins (pp. i—xxxviii).

CATALOGUE OF VOLUMES—Continued.

Vol. XXXIII. Issued May, 1879, for the Year 1879	The Eocene Flora, Vol. I, Part I, by Mr. J. S. Gardner and Baron Ettingshausen (pp. 1—38, pls. i—v). Second Supplement to the Crag Mollusca (Univalves and Bivalves), by Mr. S. V. Wood (pp. i, ii, 1—58, pls. i—vi, and title-page). The Fossil Trigoniæ, No. V, by Dr. Lycett (pp. 205—245, pl. xli, and title-page). The Lias Ammonites, Part II, by Dr. Wright (pp. 49—164, pls. ix—xviii). Supplement to the Reptilia of the Wealden (Goniopholis, Brachydectes, Nannosuchus, Theriosuchus, and Nuthetes), No. IX, by Prof. Owen (pp. 1—19, pls. i—iv). The Fossil Elephants (E. primigenius), Part II, by Prof. Leith Adams (pp. 69—146, pls. vi—xv).
,, XXXIV. Issued May, 1880, for the year 1880	The Eocene Flora, Vol. I, Part II, by Mr. J. S. Gardner and Baron Ettingshausen (pp. 39—58, pls. vi—xi). The Fossil Echinodermata, Oolitic, Vol. II, Part III (Asteroidea and Ophiuroidea), by Dr. Wright (pp. 155—203, pls. xix—xxi, pp. i—iv, and title-page). Supplement to the Fossil Brachiopoda, Vol. IV, Part III (Permian and Carboniferous), by Mr. Davidson (pp. 243—316, pls. xxx—xxxvii). The Lias Ammonites, Part III, by Dr. Wright (pp. 165—264, pls. xix—xl). The Reptilia of the London Clay, Vol. II, Part I (Chelone), by Prof. Owen (pp. 1—4, pls. i, ii).
,, XXXV. Issued May, 1881, for the Year 1881	The Fossil Echinodermata, Cretaceous, Vol. I, Part IX, by Dr. Wright (pp. 301—324, pls. lxx—lxxv). Supplement to the Fossil Brachiopoda, Vol. IV, Part IV (Devonian and Silurian, from Budleigh-Salterton Pebble Bed), by Mr. Davidson (pp. 317—368, pls. xxxviii—xlii). The Fossil Trigoniæ (Supplement No. 1), by Dr. Lycett (pp. 1—4). The Lias Ammonites, Part IV, by Dr. Wright (pp. 265—328, pls. xxii A, xxii B, xli—xlviii). The Reptilia of the Liassic Formations, Part III, by Prof. Owen (pp. 83—134, pls. xxi—xxxiii, and title-page). The Fossil Elephants (E. primigenius and E. meridionalis), Part III, by Prof. Leith Adams (pp. 147—265, pls. xvi—xxviii, and title-page).
,, XXXVI. Issued June, 1882, for the Year 1882	The Eocene Flora, Vol. I, Part III, by Mr. J. S. Gardner and Baron Ettingshausen (pp. 59—86, pls. xii, xiii, and title-page). Third Supplement to the Crag Mollusca, by the late Mr. S. V. Wood (pp. 1—24, pl. i). The Fossil Echinodermata, Cret., Vol. I, Part X, by Dr. Wright (pp. 325—371, pls. lxxvi—lxxx, and title-page). Supplement to the Fossil Brachiopoda, Vol. IV, Part V, by Dr. Davidson (pp. 369—383, and title-page). Do., Vol. V, Part I (Devonian and Silurian), by Dr. Davidson (pp. 1—134, pls. i—vii). The Lias Ammonites, Part V, by Dr. Wright (pp. 329—400, pls. xlix—lii, lii A, liii—lxix).
,, XXXVII. Issued Oct., 1883, for the Year 1883	The Eocene Flora, Vol. II, Part I, by Mr. J. S. Gardner (pp. 1—60, pls. i—ix). The Trilobites of the Silurian, Devonian, &c., Formations, Part V, by the late Mr. J. W. Salter (pp. 215—224, and title-page). The Carboniferous Trilobites, Part I, by Dr. H. Woodward (pp. 1—38, pls. i—vi). Supplement to the Fossil Brachiopoda, Vol. V, Part II (Silurian), by Dr. Davidson (pp. 135—242, pls. viii—xvii). The Fossil Trigoniæ (Supplement No. 2), by the late Dr. Lycett (pp. 5—19, pls. i—iv, and title-page). The Lias Ammonites, Part VI, by Dr. Wright (pp. 401—440, pls. lxx—lxxvii).
,, XXXVIII. Issued Dec., 1884, for the Year 1884	The Eocene Flora, Vol. II, Part II, by Mr. J. S. Gardner (pp. 61—90, pls. x—xx). The Carboniferous Entomostraca, Part I, No. 2, by Prof. T. Rupert Jones, Mr. J. W. Kirkby, and Prof. G. S. Brady (pp. i—iii, 57—92, pls. vi, vii, and title-page). The Carboniferous Trilobites, Part II, by Dr. H. Woodward (pp. 39—86, pls. vii—x, and title-page). Supplement to the Fossil Brachiopoda, Vol. V, Part III, by Dr. Davidson (pp. 243—476, pls. xviii—xxi, and title-page). The Lias Ammonites, Part VII, by Dr. Wright (pp. 441—480, pls. lxxviii—lxxxvii).

CATALOGUE OF VOLUMES—Continued.

Vol. XXXIX. Issued Jan., 1886, for the Year 1885	The Eocene Flora, Vol. II, Part III, by Mr. J. S. Gardner (pp. 91—159, pls. xxi—xxvii, and title-page). The Stromatoporoids, Part I, by Prof. Alleyne Nicholson (pp. i—iii, 1—130, pls. i—xi). The Fossil Brachiopoda (Bibliography), Vol. VI (pp. 1—163), by the late Dr. Davidson and Mr. W. H. Dalton. The Lias Ammonites, Part VIII, by the late Dr. Wright (pp. 481—503, pl. lxxxviii, and title-page).
,, XL. Issued Mar., 1887, for the Year 1886	The Morphology and Histology of Stigmaria Ficoides, by Prof. W. C. Williamson (pp. i—iv, 1—62, pls. i—xv). The Fossil Sponges, Part I, by Dr. G. J. Hinde (pp. 1—92, pls. i—viii). The Jurassic Gasteropoda, Part I, No. 1, by Mr. W. H. Hudleston (pp. 1—56). The Inferior Oolite Ammonites, Part I, by Mr. S. S. Buckman (pp. 1—24, pls. i—vi). The Pleistocene Mammalia, Part VI, by Prof. Boyd Dawkins (pp. 1—29, pls. i—vii).
,, XLI. Issued Jan., 1888, for the Year 1887	The Fossil Sponges, Part II, by Dr. G. J. Hinde (pp. 93—188, pl. ix). The Palæozoic Phyllopoda, Part I, by Prof. T. R. Jones and Dr. Woodward (pp. 1—72, pls. i—xii). The Jurassic Gasteropoda, Part I, No. 2, by Mr. W. H. Hudleston (pp. 57—136, pls. i—vi). The Inferior Oolite Ammonites, Part II, by Mr. S. S. Buckman (pp. 25—56, pls. vii—xiv).
,, XLII. Issued Mar., 1889, for the Year 1888	The Stromatoporoids, Part II, by Prof. Alleyne Nicholson (pp. 131—158, pls. xii—xix). The Tertiary Entomostraca (Supplement), by Prof. T. Rupert Jones and Mr. C. D. Sherborn (pp. 1—55, pls. i—iii). The Jurassic Gasteropoda, Part I, No. 3, by Mr. W. H. Hudleston (pp. 137—192, pls. vii—xi). The Inferior Oolite Ammonites, Part III, by Mr. S. S. Buckman (pp. 57—144, pls. xv, xxiii A). The Devonian Fauna of the South of England, Part I, by the Rev. G. F. Whidborne (pp. i, ii, 1—46, pls. i—iv). Title-pages and Prefaces to the Monographs on the Reptilia of the Wealden and Purbeck (Supplements), Kimmeridge Clay, and Mesozoic Formations, and on the Cetacea of the Red Crag.
,, XLIII. Issued Mar., 1890, for the Year 1889	The Cretaceous Entomostraca (Supplement), by Prof. T. Rupert Jones and Dr. G. J. Hinde (pp. i—viii, 1—70, pls. i—iv). The Jurassic Gasteropoda, Part I, No. 4, by Mr. W. H. Hudleston (pp. 193—224, pls. xii—xvi). The Inferior Oolite Ammonites, Part IV, by Mr. S. S. Buckman (pp. 145—224, pls. xxiv—xxxvi). The Devonian Fauna of the South of England, Part II, by the Rev. G. F. Whidborne (pp. 47—154, pls. v—viii, viii A, ix—xv).
,, XLIV. Issued Apr., 1891, for the Year 1890	The Stromatoporoids, Part III, by Prof. Alleyne Nicholson (pp. 159—202, pls. xx—xxv). The Fossil Echinodermata, Cretaceous, Vol. II, Part I (Asteroidea), by Mr. W. Percy Sladen (pp. 1—28, pls. i—viii). The Inferior Oolite Ammonites, Part V, by Mr. S. S. Buckman (pp. 225—256, pls. xxxvii—xliv). The Devonian Fauna of the South of England, Part III, by the Rev. G. F. Whidborne (pp. 155—250, pls. xvi—xxiv). Title-pages to the Supplement to the Fossil Corals, by Prof. Duncan.
,, XLV. Issued Feb., 1892, for the Year 1891	The Jurassic Gasteropoda, Part I, No. 5, by Mr. W. H. Hudleston (pp. 225—272, pls. xvii—xx). The Inferior Oolite Ammonites, Part VI, by Mr. S. S. Buckman (pp. 257—312, pls. xlv—lvi). The Devonian Fauna of the South of England, Part IV (*Conclusion of* Vol. I) (pp. 251—344, pls. xxv—xxxi, and title-page). ,, ,, Vol. II, Part I, by the Rev. G. F. Whidborne (pp. 1—56, pls. i—v).

CATALOGUE OF VOLUMES—Continued.

Vol. XLVI.	Issued Nov., 1892, for the Year 1892	The Stromatoporoids, Part IV (*Conclusion*), by Prof. Alleyne Nicholson (pp. 203—234, pls. xxvi—xxix, and title-page). The Palæozoic Phyllopoda, Part II, by Prof. T. R. Jones and Dr. Woodward (pp. 73—124, pls. xiii—xvii). The Jurassic Gasteropoda, Part I, No. 6, by Mr. W. H. Hudleston (pp. 273—324, pls. xxi—xxvi). The Inferior Oolite Ammonites, Part VII, by Mr. S. S. Buckman (pp. 313—344, pls. lvii—lxxvi). The Devonian Fauna of the South of England, Vol. II, Part II, by the Rev. G. F. Whidborne (pp. 57—88, pls. vi—x).
,, XLVII.	Issued Dec., 1893, for the Year 1893	The Fossil Sponges, Part III, by Dr. G. J. Hinde (pp. 189—254, pls. x—xix). The Fossil Echinodermata, Cretaceous, Vol. II, Part II (Asteroidea), by Mr. W. Percy Sladen (pp. 29—66, pls. ix—xvi). The Inferior Oolite Ammonites, Part VIII, by Mr. S. S. Buckman (pp. 345—376, pls. lxxvii—xcii). The Devonian Fauna of the South of England, Vol. II, Part III, by the Rev. G. F. Whidborne (pp. 89—160, pls. xi—xvii).
,, XLVIII.	Issued Nov., 1894, for the Year 1894	The Jurassic Gasteropoda, Part I, No. 7, by Mr. W. H. Hudleston (pp. 325—390, pls. xxvii—xxxii). Carbonicola, Anthracomya, and Naiadites, Part I, by Dr. W. Hind (pp. 1—80, pls. i—xi). The Inferior Oolite Ammonites, Part IX, by Mr. S. S. Buckman (pp. 377—456, pls. xciii—ciii). The Fishes of the Old Red Sandstone, Part II, No. 1, by Dr. R. H. Traquair (pp. 63—90, pls. xv—xviii).
,, XLIX.	Issued Oct., 1895, for the Year 1895	The Crag Foraminifera, Part II, by Prof. T. R. Jones (pp. 73—210, pls. v—vii). The Jurassic Gasteropoda, Part I, No. 8, by Mr. W. H. Hudleston (pp. 391—444, pls. xxxiii—xl). Carbonicola, Anthracomya, and Naiadites, Part II, by Dr. W. Hind (pp. 81—170, pls. xii—xx). The Devonian Fauna of the South of England, Vol. II, Part IV, by the Rev. G. F. Whidborne (pp. 161—212, pls. xviii—xxiv).
,, L.	Issued Oct., 1896, for the Year 1896	The Crag Foraminifera, Part III, by Prof. T. R. Jones (pp. 211—314). The Jurassic Gasteropoda, Part I, No. 9, by Mr. W. H. Hudleston (pp. 445—514, pls. xli—xliv, and title-page). Carbonicola, Anthracomya, and Naiadites, Part III, by Dr. W. Hind (pp. 171—182, pl. xxi, and title-page). The Carboniferous Lamellibranchiata, Part I, by Dr. W. Hind (pp. 1—80, pls. i, ii). The Devonian Fauna of the South of England, Vol. III, Part I, by the Rev. G. F. Whidborne (pp. 1—112, pls. i—xvi).
,, LI.	Issued Dec., 1897, for the Year 1897	The Crag Foraminifera, Part IV, by Prof. T. R. Jones (pp. vii—xv, 315—402, and title-page). The Carboniferous Lamellibranchiata, Part II, by Dr. W. Hind (pp. 81—208, pls. iii—xv). The Carboniferous Cephalopoda of Ireland, Part I, by Dr. A. H. Foord (pp. 1—22, pls. i—vii). The Devonian Fauna of the South of England, Vol. III, Part II, by the Rev. G. F. Whidborne (pp. 113—178, pls. xvii—xxi).
,, LII.	Issued Dec., 1898, for the Year 1898	The Palæozoic Phyllopoda, Part III, by Prof. T. R. Jones and Dr. Woodward (pp. 125—176, pls. xviii—xxv). The Carboniferous Lamellibranchiata, Part III, by Dr. W. Hind (pp. 209—276, pls. xvi—xxv). The Inferior Oolite Ammonites, Part X, by Mr. S. S. Buckman (pp. i—xxxii, Suppl. pls. i—iv). The Carboniferous Cephalopoda of Ireland, Part II, by Dr. A. H. Foord (pp. 23—48, pls. viii—xvii). The Devonian Fauna of the South of England, Vol. III, Part III, by the Rev. G. F. Whidborne (pp. 179—236, pls. xxii—xxxviii).

CATALOGUE OF VOLUMES—Continued.

Vol. LIII. Issued Dec., 1899, for the Year 1899
- The Palæozoic Phyllopoda, Part IV, by Prof. T. R. Jones and Dr. Woodward (pp. i—xv, 175, 176, 177—211, pls. xxvi—xxxi, and title-page).
- The Cretaceous Lamellibranchia, Part I, by Mr. H. Woods (pp. 1—72, pls. i—xiv).
- The Carboniferous Lamellibranchiata, Part IV, by Dr. W. Hind (pp. 277—360, pls. xxvi xxxix).
- The Inferior Oolite Ammonites, Part XI, by Mr. S. S. Buckman (pp. xxxiii—lxiv, pls. v—xiv).

„ LIV. Issued Dec., 1900, for the Year 1900
- The Cretaceous Lamellibranchia, Part II, by Mr. H. Woods (pp. 73—112, pls. xv—xix).
- The Carboniferous Lamellibranchiata, Part V, by Dr. W. Hind (pp. 361—476, pls. xl—liv).
- The Carboniferous Cephalopoda of Ireland, Part III, by Dr. A H. Foord (pp. 49—126, pls. xviii—xxxii).
- The British Pleistocene Mammalia, Title-page for Vol. I, by Messrs. Dawkins and Sanford.
- The Structure of Carboniferous Plants, Title-page, by Mr. E. W. Binney.

„ LV. Issued Dec., 1901, for the Year 1901
- The Cretaceous Lamellibranchia, Part III, by Mr. H. Woods (pp. 113—144, pls. xx—xxvi).
- The Carboniferous Lamellibranchiata, Vol. II, Part I, by Dr. W. Hind (pp. 1—34, pls. i—vi), Title-page and Index for Vol. I.
- The Carboniferous Cephalopoda of Ireland, Part IV, by Dr. A. H. Foord (pp. 127—146, pls. xxxiii—xxxix).
- British Graptolites, Part I, by Miss Elles and Miss Wood, edited by Prof. Lapworth (pp. 1—54, pls. i—iv).
- Ganoid Fishes of British Carboniferous Formations—Part I, Palæoniscidæ, No. 2, by Dr. Ramsay H. Traquair (pp. 61—87, pls. viii—xviii).

„ LVI. Issued Dec., 1902, for the Year 1902
- The Cave Hyæna, by Prof. S. H. Reynolds (pp. 1—25, pls. i—xiv).
- The Fishes of the English Chalk, Part I, by Dr. A. Smith Woodward (pp. 1—56, pls. i—xiii).
- The Cretaceous Lamellibranchia, Part IV, by Mr. H. Woods (pp. 145—196, pls. xxvii—xxxviii).
- British Graptolites, Part I, No. 2,, by Miss Elles and Miss Wood, edited by Prof. Lapworth (pp. i—xxviii, 55—94, pls. v—xiii).

„ LVII. Issued Dec., 1903, for the Year 1903
- The Fishes of the English Chalk, Part II, by Dr. A. Smith Woodward (pp. 57—96, pls. xiv—xx).
- The Cretaceous Lamellibranchia, Part V, by Mr. H. Woods (pp. i—xliii, 197—232, pls. xxxix—xlii), Title-page and Index for Vol. I.
- The Carboniferous Lamellibranchiata, Vol. II, Part II, by Dr. W. Hind (pp. 35—124, pls. vii—xxi).
- The Carboniferous Cephalopoda of Ireland, Part V, by Dr. A. H. Foord (pp. 147—234, pls. xl—xlix), Title-page and Index.
- The Lower Palæozoic Trilobites of Girvan, Part I, by Mr. F. R. Cowper Reed (pp. 1—48, pls. i—vi).
- British Graptolites, Part III, by Miss Elles and Miss Wood, edited by Prof. Lapworth, (pp. xxix—lii, 103—134, pls. xiv—xix).

„ LVIII. Issued Dec., 1904, for the Year 1904
- The Fishes of the Old Red Sandstone, Part II, No. 2, by Dr. R. H. Traquair (pp. 91—118, pls. xix—xxvi).
- The Cretaceous Lamellibranchia, Vol. II, Part I, by Mr. H. Woods (pp. 1—56, pls. i—vii).
- The Carboniferous Lamellibranchiata, Vol. II, Part III, by Dr. W. Hind (pp. 125—216, pls. xxii—xxv).
- The Inferior Oolite Ammonites, Part XII, by Mr. S. S. Buckman (pp. lxv—clxviii, pls. xv—xix).
- The Lower Palæozoic Trilobites of Girvan, Part II, by Mr. F. R. Cowper Reed (pp. 49—96, pls. vii—xiii).
- British Graptolites, Part IV, by Miss Elles and Miss Wood, edited by Prof. Lapworth, (pp. liii—lxxii, 135—180, pls. xx—xxv).

CATALOGUE OF VOLUMES—Continued.

Vol. LIX.	Issued Nov., 1905, for the Year 1905	The Fossil Echinodermata, Cretaceous, Vol. II, Part III, by Mr. W. K. Spencer (pp. 67—90, pls. xvii—xxvi). The Cretaceous Lamellibranchia, Vol. II, Part II, by Mr. H. Woods (pp. 57—96, pls. viii—xi). The Carboniferous Lamellibranchiata, Vol. II, Title-pages and Index, by Dr. W. Hind. The Inferior Oolite Ammonites, Part XIII, by Mr. S. S. Buckman (pp. clxix—ccviii, pls. xx—xxiv). The Cornbrash Fauna, Part I, by Rev. J. F. Blake (pp. 1—100, pls. i—ix).
,, LX.	Issued Dec., 1906, for the Year 1906	The Pleistocene Bears, by Prof. S. H. Reynolds (pp. 1—35, pls. i—viii). The Fishes of the Old Red Sandstone, Part II, No. 3, by Dr. R. H. Traquair (pp. 119—130, pls. xxvii—xxxi). The Cretaceous Lamellibranchia, Vol. II, Part III, by Mr. H. Woods (pp. 97—132, pls. xii—xix). The Lower Palæozoic Trilobites of Girvan, Part III, by Mr. F. R. Cowper Reed (pp. 97—186, Title-page and Index, pls. xiv—xx). The Cambrian Trilobites, Part I, by Mr. P. Lake (pp. 1—28, pls. i, ii). British Graptolites, Part V, by Miss Elles and Miss Wood, edited by Prof Lapworth (pp. lxxiii—xcvi, 181—216, pls. xxvi, xxvii).

Palæontographical Society, 1906.

A MONOGRAPH

OF THE

BRITISH PLEISTOCENE MAMMALIA

VOL. II, PART II.

THE BEARS.

BY

SIDNEY H. REYNOLDS, M.A., F.G.S.,

PROFESSOR OF GEOLOGY AND ZOOLOGY, UNIVERSITY COLLEGE, BRISTOL.

Pages 1—35; Plates I—VIII.

LONDON:
PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.
1906.

PRINTED BY ADLARD AND SON, LONDON AND DORKING.

MONOGRAPH

ON

THE BRITISH MAMMALIA

OF THE

PLEISTOCENE PERIOD.

THE BEARS.

Order—CARNIVORA.

Family—URSIDÆ.

Genus—Ursus.

I. HISTORICAL INTRODUCTION.

The fossil bears form a group of animals whose study is by no means easy, not from any scarcity of their remains, but from the difficulty of coming to a decision about the mutual relationship of the various living and fossil forms. Very divergent opinions have been expressed with regard to the number of species of bears, and the literature dealing with the subject is remarkably extensive. Cuvier[1] and de Blainville[2] treat of the early discoveries of fossil bears very fully, and their accounts have been freely used in the following pages.

Fossil bones, which eventually proved to be those of bears, were first mentioned by J. Paterson Hayn[3] (1672), who considered them to be the bones of dragons. He obtained representatives of nearly all parts of the skeleton from a cave in Mount Krapacks, Hungary. H. Vollgnad[4] (1673) referred to the same bones, again considering them to be the remains of dragons.

[1] 'Oss. Foss.,' ed. 1, 1812, tom. iv, part iv.

[2] 'Ostéographie,' tom. ii, K.

[3] 'Éphém. Curieux de la Nature,' dec. i, an. iii, obs. cxxxix, p. 220.

[4] Ibid., an. iv, obs. clxx, p. 226.

F. E. Brückmann[1] (1732) was the first to compare these cave-bones with those of bears. J. F. Esper[2] (1774) gave figures of a large number of bear-bones found in a cave in Franconia, but in default of material for comparison was unable to decide definitely that they belonged to bears, though he noted the resemblance. Later on Esper[3] (1784), having obtained the skull of a polar bear, adopted the view that the cave remains were to be attributed to the same species.

In 1794 John Hunter[4] compared a fossil skull, which had been referred to the polar bear, with the skull of the last-mentioned species, and noted various differences, though cautiously observing that great changes in the shape of the skulls of Carnivora occur during their growth to maturity and old age.

In 1795 J. C. Rosenmüller[5] recognised differences between the brown, white, and cave bears, and gave a table of comparison between the skulls of these three forms printed in parallel columns. He was also the first to apply the name *Ursus spelæus* to the cave bear.

In 1804 Rosenmüller[6] published a folio volume in French and German dealing solely with the cave bears, and fully described their remains, concluding with a suggestive chapter on the conditions under which bones found in caves might have accumulated. He also emphasised the fact that differences in skulls depend not only on age (as noted by Hunter), but also on sex.

Meanwhile, the study of fossil bears was undertaken by Blumenbach and Cuvier. The former[7] arrived at the conclusion that the German caves contained not only *Ursus spelæus*, which he regarded as distinct from all living species, but also another form which he named *U. arctoideus*, intending thus to indicate its relationship to the brown bear. Cuvier[8] (1806) confirmed Blumenbach's statement that some of the larger bones from the German caves indicated specific differences from all living bears, and also agreed with the suggestion that they represented two extinct forms—*U. spelæus* with the forehead arched, *U. arctoideus* with the forehead flat—the latter approaching living species more closely than the former.

1 'Breslauer Samml.,' 1732, p. 628; and 'Epist. Itin.,' 32.

2 'Ausführliche Nachricht zoolith. Bayreuth.'

3 'Écrits Soc. nat. Berlin,' v, p. 56.

4 'Phil. Trans.,' lxxxiv, 1794, p. 407.

5 'Beitr. Geschicht. foss. Knochen,' p. 44 (German reprint of the same author's 'De Oss. foss.,' Leipzig, 1794).

6 Abbild. u. Beschreib. der foss. Knochen des Höhlenbären,' Weimar.

7 Quoted by Cuvier, 'Bull. Sci., Soc. Philomath.,' no. 50. This reference is taken from de Blainville, 'Ostéographie,' Carnassiers, p. 46. It is quoted apparently from him by Owen, 'Brit. Foss. Mamm.,' p. 86, and by other subsequent writers. In the official catalogue of Cuvier's papers the title appears without any reference as to where the paper can be found. The paper cannot be traced, and was probably suppressed.

8 'Annales du Muséum,' vii, p. 324.

In 1810 Goldfuss[1] published a memoir in which he attempted to distinguish a third species of fossil bears, named *U. priscus.* This was accepted by Cuvier.[2] Meanwhile the fossil bones of bears were being discovered in several localities in England, notably in the caves of Kirkdale, Yorkshire (whence Buckland[3] described rare fragments), and Oreston, near Plymouth (Clift and Whidbey).[4]

In 1825 Cuvier in the third edition of 'Ossemens Fossiles' reverted[5] to the conclusion that the forms called *U. spelæus* and *arctoideus* were only varieties of the same species. De Blainville, however, remarked[6] that Cuvier's unfortunate establishment of a new species on insufficient evidence gave an impulse to this practice, which was exaggerated in the hands of less skilful palæontologists. In proof of this he referred to Croizet and Jobert[7] (1828) who believed they could recognise *U. cultridens* by a single canine, and sought to establish a new species *U. arvernensis* on a fragment of the anterior part of the skull, a humerus and other isolated bones. The work of M. de Serres[8] is an instance of the same method.

P. C. Schmerling[9] (1833), although he corrected certain mistakes of Cuvier, was led by his example to establish several new species on material more or less incomplete. He concluded that no less than five species of bears lived in the Liège district—viz., *U. spelæus* and *arctoideus*, Blum., *U. priscus*, Goldf., and two new species, *U. giganteus* and *leodiensis*. In 1842 Owen[10] described a fine skull of the brown bear from Manea fen, Cambridge.

With the increase of knowledge and facilities for comparison, the extreme difficulty of recognising specific distinctions between the various bears began to be apparent, with a tendency to group together several forms which had previously been regarded as distinct species. This tendency was first shown by de Blainville[11] who in 1844 gave a detailed and critical account of the different kinds of fossil bears with splendid illustrations. Further reference to his conclusions follows later, but it may be mentioned here that he considered all the bears, living and fossil, found in Europe to belong to one species, but thought there were two races of fossil bears, a larger race the male of which was represented by *U. giganteus* and *U. spelæus major* and the female by *U. arctoideus* and *U. leodiensis*, and a smaller race in which the male was represented by *U. spelæus minor* and the female by *U. priscus*. He considered that a second small species was represented by *Ursus*

1 'Verhandl. kaiserl. Leopold.-Karolin. Akad. der Naturforscher,' x, 2, p. 260.

2 'Oss. Foss.,' ed. 3, 1825, iv, p. 380.

3 'Reliquiæ diluvianæ,' ed. 2, p. 17; and 'Phil. Trans.,' 1822, p. 171.

4 'Phil. Trans.,' cxiii, 1823, p. 88.

5 Tom. iv, p. 358.

6 'Ostéographie,' Carnassiers, p. 50.

7 'Rech. Oss. foss. Puy de Dome,' p. 628.

8 'Bull. univ. des Sci. Nat.,' 1830, xii, no. 19, p. 161.

9 'Recherches Oss. foss. Cavernes de Liège.'

10 'Rep. Brit. Assoc.,' 1842, p. 69.

11 'Ostéographie,' Carnassiers, p. 38.

arvernensis. He doubted the distinction of the bears of north-western America (*i.e.* the grizzly bear) from the European species. This view was also accepted by Middendorff (1851),[1] who concluded that all the bears of the *arctos* group from both eastern and western hemispheres were varieties of one species.

On the other hand, Owen in 1846 in his 'British Fossil Mammals and Birds' dealt fully with the British fossil bears, recognising three species, *U. spelæus*, *U. arctos*, and *U. priscus*, Goldf., to which species he attributed a lower jaw from Kent's Cavern. J. A. Wagner[2] also (1851) agreed with Owen in recognising more than one species among the bears of the *arctos* group and considered de Blainville's views on the subject to be retrogressive. Gray[3] (1864) went farther in the process of subdivision than anyone else, separating the living bears not only into a number of species, but also into several genera.

The descriptions of the bones of bears from a number of Irish localities now commenced—*e.g.* by R. Ball,[4] A. Carte,[5] and H. Denny.[6] Some of the bones found were even attributed to the polar bear.

Müller[7] (1872), in a beautifully illustrated work on certain bears' skulls from Russia, doubted the possibility of distinguishing between the different species of fossil bears even by their teeth.

In 1867 appeared the first of a series of important communications from Busk dealing with the fossil bears. In this paper, of which, unfortunately, only an abstract was published,[8] he mentioned that the teeth on which reliance was to be placed in distinguishing the different species of fossil bears were $\overline{\text{pm. 4}}$, $\underline{\text{pm. 4}}$, $\underline{\text{m. 2}}$, $\overline{\text{m. 3}}$. He expressed the opinion that *U. priscus* was identical with *U. ferox.* In 1873 appeared his very important paper[9] on the animal remains found in the Brixham cave, in which he fully discussed the mutual relationship of the various species of fossil bears. He established the fact that *U. priscus*, Cuv., was identical with *U. fossilis*, Goldf., and *U. ferox*, the modern grizzly, and considered that all the Irish specimens were referable to the latter species. He thought that *U. ferox (priscus)* was commoner even in England than *U. spelæus.* He discussed the differences by which, according to Owen, the teeth of *U. spelæus*, *U. arctos*, and *U. ferox* could be distinguished, but thought that these differences were not all constant and considered that it would be impossible to distinguish between the

[1] 'Untersuch. Schädeln des gemeinen Landbaren,' etc., St. Petersburg.

[2] 'Abhandl. k. bay. Akad. Wissensch.,' vi, I Abth., 1851, p. 193.

[3] 'Cat. Carniv. Pachyderm. and Edentate Mamm. in Brit. Mus.,' p. 217.

[4] 'Proc. R. Irish Acad.,' iv, 1849, p. 146.

[5] 'Journ. R. Dublin Soc.,' ii, 1860, p. 344; and 'Journ. R. Geol. Soc. Dublin,' x, 1864, p. 114.

[6] 'Proc. Yorks. Geol. and Polyt. Soc.,' iv, 1864, p. 347.

[7] 'Drei in der Provinz Preussen ausgegrabene Bärenschädel.'

[8] 'Q. J. Geol. Soc.,' xxiii, 1867, p. 342; and 'Phil. Mag.,' xxxiv, 1867, p. 399.

[9] 'Phil. Trans.,' clxiii, p. 532.

three species in respect of the teeth. He returned to the subject four years later in his 'Report on the Ancient or Quaternary Fauna of Gibraltar,'[1] in which he discussed minutely the characters of the cave, brown, and grizzly bears as based upon their teeth, stating his belief that no character of specific importance could be drawn from any part of the bear's skeleton except the teeth.

The question of the relationship of the fossil bears was further considered by R. Hensel[2] (1876). Basing his view on a study of the teeth, he urged the distinction of the cave bear, but did not express a clear opinion as to whether the other Pleistocene bears represented more than one species. In 1877 Boyd Dawkins,[3] who had already[4] commented on the extreme difficulty of distinguishing between the brown and grizzly bears by means of their hard parts, adopted the view of their identity.

About this time A. L. Adams commenced a series of important papers in which he discussed the Irish specimens. In the earliest[5] of these (1878) he referred the specimen described by Carte as *U. maritimus* to *U. ferox*, and in the second[6] he gave a critical account of all the Irish bear-remains, referring them all to *U. ferox*, the grizzly bear, which he concluded was the only bear whose remains had been proved to occur in Ireland. In a later paper[7] the same author, in describing further remains of Irish bears, was the first to suggest that those known as *U. spelæus* might be only those of large individuals of *U. ferox*. He confirmed Busk's and his own previously expressed opinion, that all the remains of Irish bears were referable to *U. ferox*. The paper included a table of dimensions of bears' crania. The following year (1881) Adams published another paper[8] further developing his suggestion that the differences between fossil bear-remains may be racial, sexual, or even individual, dependent on mode of life or character of food, and that the different British fossil bears may best be regarded as races of one species.

Later writers have also discussed fully the mutual relationship of the bears, and very varying opinions have been reached.

Lydekker,[9] writing in 1884, gave dental characters by which the brown and grizzly bears might be distinguished, but a year later doubted[10] whether a valid distinction of this kind was possible. In 1897 he separated[11] *U. spelæus* as a species, grouping all the bears of the *arctos* group (*i. e.* all those of the northern

[1] 'Trans. Zool. Soc.,' x (2), 1877, p. 60. [2] 'Sitzb. Naturf. Freunde, Berlin,' p. 49.
[3] 'Q. J. Geol. Soc.,' xxxiii, 1877, p. 598. [4] Ibid., xxxii, 1876, p. 248.
[5] 'Proc. R. Irish Acad.,' 2nd series, iii, 1878, p. 94.
[6] 'Journ. R. Geol. Soc. Ireland,' iv, 1877, p. 247.
[7] 'Sci. Proc. R. Dublin Soc.,' ii, 1880, p. 49.
[8] 'Trans. Roy. Dublin Soc.' (2), i, 1881, p. 201.
[9] 'Palæont. Indica,' ser. 10, ii, 1884, p. 202.
[10] 'Cat. Foss. Mamm. Brit. Mus.,' pt. i, p. 173.
[11] 'Proc. Zool. Soc.,' 1897, p. 412.

hemisphere except the polar bear, the American black bear, and the blue bear of Thibet) as one species. A. E. Brown[1] (1894) went farther than this, including even the American black bear as a subspecies of *U. arctos*. In this view he was in accordance with that previously reached by Allen,[2] who, however, afterwards changed his opinion[3] with regard to this point. In the paper just referred to[3] he gave a valuable table of measurements showing the great individual variability in bears' skulls from the same locality, and considered that, though *U. americanus* might be distinct, there was a complete passage between the brown and grizzly bears.

The remarkable individual variability was still more impressively shown by E. Schäff[4] (1889) in a paper on a collection of thirty-five skulls all obtained from a limited area in Russia. The variability of the European bears was shown to be more than paralleled by those of America in C. H. Merriam's paper,[5] which was based on a study of more than two hundred skulls, a series of as many as ninety-five having been obtained from one locality. The conclusions which he drew were, however, widely different from those drawn by Brown and Allen; for he not only considered that the American "brown" bears (of which he made a number of new species) were specifically distinct from the European, but separated the black bear subgenerically.

The difficulty of distinguishing between the different species of fossil bears is further illustrated by the important papers by Gaudry and Boule,[6] and E. T. Newton.[7] The former authors showed that even the loss of the three anterior upper premolars is not absolutely characteristic of the cave bear, as individuals of the smaller race from Gargas retain $\underline{\text{pm. 3}}$. The close connection between the bears of the brown and grizzly types is illustrated by the fact that they considered *U. priscus* to come nearer to *U. arctos*, especially as regards the humerus, than to *U. horribilis*, with which it is usually thought to be identical.

Newton, in describing the Vertebrata from the Forest Bed, agreed with Owen in assigning the jaw figured in the 'British Fossil Mammals,' p. 106, to *U. spelæus*, in spite of its small size, while he assigned another specimen to *U. spelæus* in spite of its retaining $\overline{\text{pm. 1}}$.

1 'Proc. Acad. Nat. Sci. Philad.,' xlvi, 1894, p. 119.
2 'Bull. Mus. Comp. Zool.,' i, 1869, p. 184.
3 'Bull. U. S. Geol. Surv. of Territories,' ii, no. 4, 1876, p. 334.
4 'Archiv für Naturgeschichte,' 1889, p. 244.
5 'Proc. Biol. Soc. Washington,' x, 1896, pp. 65–83.
6 'Mat. pour l'histoire des temps quaternaires,' fasc. iv, p. 105 (1892).
7 "Vertebrata of Forest Bed Series," 'Mem. Geol. Surv.,' p. 5 (1882).

II. DISTRIBUTION IN BRITAIN AND ELSEWHERE.

The oldest British formation from which the fossil remains of bears have been described is the Suffolk Crag. Owen,[1] writing in 1846, says "the oldest fossil referable to the genus *Ursus* from British strata is the crown of a molar tooth, which was found at Newbourn, near Woodbridge, Suffolk. The bear's tooth is the antepenultimate grinder of the right side, upper jaw; it is smaller than the corresponding tooth in *U. spelæus*." Newton[2] was, unfortunately, unable to verify this determination, and suggests that the tooth may be attributable to *Sus*. In 1864 Lankester[3] described and figured a slender canine tooth, also said to have come from the Red Crag of Newbourn, near Woodbridge. This specimen, which is in the Reed collection at York, he referred with little hesitation to *U. arvernensis*. Boyd Dawkins, and Newton[2] have both doubted the correctness of this identification, the latter saying "it seems more probable it will prove to be an anterior tooth of *Squalodon* and, therefore, cannot be taken as evidence of the occurrence of *Ursus* in the Red Crag."

The Forest Bed is the oldest British formation in which undoubted bears' bones have been found. The best specimens were originally described by Owen,[4] and they have been re-examined and described by Newton.[5] The specimens found were at first attributed to as many as four species of bears—*U. spelæus*, *arvernensis*, *etruscus*, and *priscus* (= *horribilis*). The best specimen described by Owen is a small mandible,[6] which, in spite of its small size, is referred to *U. spelæus* for the following reasons: (1) There is a long diastema between the canine and the first tooth of the molar series, $\overline{\text{pm. 4}}$; (2) $\overline{\text{pm. 4}}$ has a complicated form; (3) $\overline{\text{m. 3}}$ is broad as compared with the same tooth in the brown and grizzly bears. Owen's identification is endorsed by Newton. Another specimen[7] has $\overline{\text{pm. 1}}$ present, but in spite of this fact is referred by Newton to *U. spelæus*, while a third and larger specimen[8] agrees with the normal *spelæus* in the complete absence of the anterior premolars. Of the sixteen specimens found in the Forest Bed, nine are referred by Newton without hesitation to *U. spelæus*, and probably two more belong to this species.

The supposed occurrence of *U. arvernensis* is based on a fragment of the right maxilla with two teeth, now in the Museum of Practical Geology. It has been regarded by Dawkins as probably referable to *U. arvernensis*. Newton considered that there was no evidence to show the correctness of this attribution, and regarded

[1] 'Brit. Foss. Mamm. and Birds,' p. 105 (1846).

[2] 'Mem. Geol. Surv.,' "Vert. of Pliocene Deposits," p. 15 (1891).

[3] 'Ann. Mag. Nat. Hist.' (3), xiv, p. 358.

[4] 'Brit. Foss. Mamm. and Birds,' p. 89 (1846).

[5] 'Mem. Geol. Surv.,' "Vert. of Forest Bed Series," pp. 5—16 (1882).

[6] Fig., ibid., pl. i (1).

[7] Fig., ibid., pl. i (2).

[8] Fig., ibid., pl. i (3).

the size of the teeth as too great, *U. arvernensis* being a small species. He considered it far more probable that the fragment was to be referred to the grizzly bear. Newton summarised his views with regard to the occurrence of *U. arvernensis* as follows[1]: "No description of a specimen of *U. arvernensis* from these deposits has ever been published, although the name has been admitted in the list of mammals. If such a specimen is in existence its resting place is not known and one is compelled, therefore, to omit the species until evidence of its existence is

Table showing the Distribution of the British Pleistocene Bears.

River Deposits, etc.	Cave.	Brown.	Grizzly.	Caves and Fissures.	Cave.	Brown.	Grizzly.
Acton	...	...	*	Bacon Hole, Gower	*	...	...
Ballymahon on borders of Longford and Westmeath	...	*	...	Ballynamintra, co. Waterford	...	...	*
Ballinamore, co. Leitrim	...	...	*	Banwell	*	...	...
Barrington	*	*	...	Bleadon	*	*	...
Bedford	?	...	...	Bosco's Hole, Gower	*	...	...
Bourne, Lincoln	...	*	...	Brixham	*	*	*
Burwell Fen	...	*	...	Burrington	*	...	...
Clonburne, King's co.	...	...	*	Cae Gwyn, Clwyd Vale	?	...	...
Copford	...	...	?	Cefn, near St. Asaph	*	...	*
Crayford	...	*	...	Chudleigh	...	...	?
Dumfries	...	*	...	Clevedon	...	?	...
Grays, Essex	...	*	*	Cresswell Crags, Derbyshire	...	?	?
Ilford	...	...	?	Crow Hole, Gower	*	...	...
Ipswich	...	...	*	Deborah Den, Gower	?	*	?
Kew Bridge	...	...	*	Durdham Down	*	*	...
Kilrathmurray, co. Kildare	...	*	*	Edenvale, co. Clare	...	*	...
King's co.	...	...	*	Enniskillen	...	...	*
Longford	...	...	*	Hoe Grange, Longcliffe, Derbyshire	...	...	*
Lough Gur, co. Limerick	...	...	*	Hutton	*	*	...
Manea Fen	...	*	...	Ightham fissure	...	?	...
Murston	?	?	?	Kent's Hole, Torquay	*	*	*
Newbury, Berks.	?	...	?	Kesh, Sligo	...	*	...
Stonehouse	...	...	*	Kirby Moorside	*	...	...
Tewkesbury	...	...	?	Kildare	...	...	*
Walton, Essex	...	...	?	Kirkdale	*	*	*
Waterford	...	...	*	Llandeilo	...	*	...
Westmeath	...	*	*	Long Hole, Gower	*	...	...
Whitesand Bay, St. David's	...	?	...	Minchin Hole, Gower	*	...	*
Whitstable	...	...	?	Oreston	...	*	*
Windsor	?	...	...	Paviland, Gower	*	*	...
Woodbridge	...	...	*	Pinxies Cave	?	...	...
Great Yeldham, Essex	...	*	...	Ravenscliff, Gower	*	...	...
				Sandford	*	*	...
				Shandon Cave, Dungarvon	...	...	*
				Spritsail Tor, Gower	*	*	*
				Uphill	*	...	...
				Windy Knoll, Castleton	*	...	*
				Wookey Hole	*	*	*
				Yealm Bridge	*	...	...

Note.—In each case the attribution of the bones, whether to the cave, brown, or grizzly bear, has simply been copied from previous authors, and does not imply an expression of opinion on the part of the present writer.

[1] "Vert. of Forest Bed Series," p. 16 ('Mem. Geol. Surv.,' 1882).

forthcoming." With regard to the fourth species, *U. etruscus*, the evidence for its inclusion is even slighter. It was doubtfully included in the list of the Forest Bed mammals by Prestwich in 1872 on the authority of Boyd Dawkins, but the specimen has not been described or figured.

During Pleistocene times bears were very plentiful in England, ranging also into North and South Wales, and occurring at a number of localities in Ireland. They do not appear to have been met with in Scotland north of Dumfries. But while very widespread in England, their remains are not, as a rule, so plentiful as those of the hyæna, and they are by no means so abundant as in some parts of the continent, such as the limestone districts of Belgium and Moravia.

The table of localities on the previous page is based on that of Boyd Dawkins[1], published in 1869, but the bones of bears have, as was to be expected, been found in several fresh localities since his list was prepared.

The most noteworthy point about the above list from Pleistocene river deposits is the large number of records of the grizzly bear especially from Ireland, while of the cave bear the records are few and mostly of a doubtful character. Till recently none of the bones found in Irish caves were attributed to the brown bear, but Scharff, who has been unable to recognise valid distinctions between *U. arctos* and *U. horribilis*, has applied the former name to the remains of bears from the caves of Kesh,[1] co. Sligo, and Edenvale,[2] co. Clare. An interesting point about the Irish bear-remains is their relatively perfect and uninjured character. Adams suggests that this may be due to the non-occurrence of the bone-crushing hyæna in Ireland.

The cave bear has been recorded from twenty-six British caves, as compared with seventeen records of the occurrence of the brown, and fourteen of the grizzly bear. Busk considered that the grizzly was more abundant than the cave bear, even in England, and was the only bear met with in Ireland.

No large and associated series of bones of bears from British localities occurs in any museum comparable with the series of hyæna bones at Taunton ; and the specimens figured are preserved in several collections. I am much indebted to Mr. H. A. Allen, Mr. H. St. G. Gray, Prof. T. Mc K. Hughes, Dr. R. F. Scharff, and Dr. A. Smith Woodward, for facilities in the figuring of specimens preserved in the Museum of Practical Geology, the Taunton Castle Museum, the Sedgwick Museum, the National Museum of Science and Art, Dublin, and the British Museum (Natural History) respectively.

I wish also to thank Dr. Smith Woodward, Dr. Andrews, and Mr. C. D. Sherborn for help and advice, and Mr. J. Green for the great care and skill he has shown in drawing the plates and figures.

[1] 'Quart. Journ. Geol. Soc.,' xxv, 1869, p. 192.

[2] 'Trans. Roy. Irish Acad.,' xxxii, B, pt. 4, p. 201.

[3] Ibid, xxxiii, B, pt. 1, p. 43.

III. DESCRIPTION OF THE REMAINS.

It may be well to begin with a statement of the distinctive osteological characters of bears. They agree with the other Arctoidea in the following respects [1]: (1) there are five well-developed digits; (2) the auditory bulla is simple with no trace of a dividing septum, and the inferior lip of the auditory meatus is considerably prolonged; (3) the paroccipital process of the exoccipital is more or less triangular and is directed backwards, outwards, and downwards, standing quite apart from the bulla; (4) the mastoid process of the periotic is widely separated from the paroccipital and generally very prominent; (5) the carotid foramen is large and placed on the inner margin of the bulla, usually near the middle, but occasionally more posteriorly; (6) the condyloid foramen is distinct and exposed and never sunk into a common opening with the foramen lacerum posterius; (7) the glenoid foramen is always present and usually conspicuous; (8) a large penial bone occurs.

The family Ursidæ is characterised by the following features:[2] In existing forms the true molars are $\frac{2}{3}$ and have broad flat tuberculated crowns. The three anterior premolars of both jaws are rudimentary and often deciduous. The fourth upper premolar, the carnassial tooth, has no third or inner root. An alisphenoid canal is present. The auditory bulla is depressed and scarcely at all inflated. The feet are plantigrade. There is no entepicondylar foramen to the humerus.

As noted by de Blainville, a bear's skeleton presents certain resemblances to that of man, dependent partly on the animal's habit of sitting on the ischia, partly on the plantigrade method of walking.

A. The Skull (Plates I—V).

(1) *Distinctive Features of the Skull in the Genus* Ursus.—The skull is more or less elongated. The orbits are small and the post-orbital bar is incomplete. The palate is prolonged considerably behind the last molar tooth. An alisphenoid canal is present. The pterygoid has a well-developed hamular process.

The following are the features in the skulls and teeth of bears, in which the greatest amount of variation takes place, and to which special attention should be paid in attempting to discriminate between the different species:

(1) The presence or absence of the anterior premolars;

(2) The length of the interspace between $\underline{\text{c.}}$ and $\underline{\text{pm. 4}}$, and between $\overline{\text{c.}}$ and $\overline{\text{pm. 4}}$;

(3) The form of $\overline{\text{pm. 4}}$ and $\overline{\text{m. 3}}$;

(4) The width of the posterior narial opening;

(5) The shape of the jugal arcade;

[1] Flower and Lydekker, 'Mammals Living and Extinct,' p. 586.

[2] Ibid., p. 556.

(1) TABLE OF COMPARATIVE MEASUREMENTS OF BEAR SKULLS.

	U. spelæus, Banwell, Beard coll. (Taunton Mus.).	*U. spelæus*, Banwell (Taunton Mus.).	*U. spelæus*, Sandford (Taunton Mus.).	*U. spelæus*, Sundwig, Westphalia, No. 28544 (Brit. Mus.).	*U. spelæus*, Jersmanowice, Rus. Poland (Brit. Mus.).	*U. priscus=horribilis*, Muggendorf, Baireuth (Brit. Mus.).	*U. horribilis*, Clonburne, King's Co. No. 214 (Brit. Mus.).	*U. horribilis*, Ballinmore, Leitrim (Brit. Mus.).	*U. arctos*, Burwell fen (Sedgwick Mus., Cambridge).	*U. arctos*, Bourne, Lincoln (Jermyn St. Mus.).	*U. arctos*, Manea fen, Cambs. (Sedgwick Mus., Cambridge.)	*U. horribilis*, Yellowstone River, Montana, No. 854, (R. Coll. of Surgeons Mus.).	*U. horribilis*, No. 58.6.18.10. (Brit. Mus.).	*U. horribilis* var. *horriæus*, No. 67.2.23.3. (Brit. Mus.).	*U. arctos* No. 218e (Brit. Mus.).	*U. arctos*, Kamtchatka, No. 91.12.18.13 (Brit. Mus.).	*U. arctos* var. *piscator*, N.W. Asia, No. 93.9.10.1. (Brit. Mus.).
1. Length from intercondylar notch to anterior end of skull	...	42·0	35·5	44·3	43·3	31·5	32·2	35·8	36·0	33·6	29·55	30·5	34·85	30·1	32·2	34·7	35·9
2. Length of space between $\underline{\text{c}}$. and $\underline{\text{pm. 4}}$	...	...	...	4·65	5.05	3·1	3·7	3·25	...	3·1	...	...	3·6	2·65	2·85	3·7	4·1
3. Length of space between $\overline{\text{c}}$. and $\overline{\text{pm. 4}}$	...	...	...	...	...	4·1	...	...	...	...	...	...	4·65	3·9	3·95	4·2	5·25
4. Extreme width across zygomatic arches	...	...	21·3	31·5	31·9	19·4	22·0	25·4	19·5	24·25	19·9	21·0	20·9	22·4	25·1	26·0	25·1
5. Vertical height from suture between basi-occipital and basi-sphenoid to top of sagittal crest	...	14·35	...	13·45	14·7	9·2	10·25	11·75	8·4	10·9	8·1	9·6	11·45	9·4	11·1	11·2	11·9
6. Width immediately above lachrymal foramen	12·55	...	8·1	9·7	10·8	7·1	7·8	9·4	7·9	8·65	7·65	8·15	8·5	7·55	9·8	9·1	9·1
7. Width between ends of post-orbital processes	19·8	...	...	15·15	14·15	10·6	10·65	13·45	10·5	12·6	11·15	11·5	12·7	12·5	14·85	13·8	15·35
8. Width measured from alveolar border immediately above second upper premolars	12·55	...	9·65	12·1	12·8	9·45	9·45	10·0	9·0	9·1	8 3	8·65	8·7	8·4	9·0	10·05	9·3
9. Minimum width in front of foramen lacerum anterius	...	...	...	3·8	...	3·9	4·3	4·4	3·65	3·6	3·3	3·7	4·5	3·3	4·15	4·8	3·4
10. Transverse measurement across occipital condyles	...	9·0	7·35	8·9	8·65	7·1	7·1	8·1	6·5	7·45	6·7	6·2	7·2	6·5	6·7	7·55	7·5
11. Transverse measurement across external auditory meatus	22·6	...	14·1	18·4	16·85	13·4	13·2	15·2	12·0	14·05	12·55	13·6	14·75	13·7	15·55	15·5	16·45
12. Transverse measurement across mastoid process of periotic	29·0	...	16 9	21·9	20·8	14·3	16·9	20·8	14·55	15·95	14·3	15·25	17·25	15·95	19·3	18·8	20·6
13. Transverse diameter of foramen magnum	...	3·95	3·2	3·7	3·75	3·25	3·7	4·05	2·9	3·3	3·0	...	2·7	2·7	2·6	3·4	3·3
14. Maximum diameter of anterior narial opening	6·7	...	5·35	6·45	7·0	4·2	5·35	5·3	4·45	4·35	4·55	...	5·8	4·8	4·95	5·45	4·9
15. Width of posterior narial opening at pterygoid suture	...	...	...	3·0	...	3·7	3 05	3·15	3·0	2·6	2·6	...	3·65	2·5	3·6	3·3	3·4
16. Maximum length of mandibular ramus measured to end of condyle	...	...	27·0	...	...	23·2	...	...	23·9	...	...	...	27·2	24·0	24·2	26·25	26·0
17. Height from angle to top of coronoid process	...	...	...	...	...	9·55	...	...	9·5	...	...	...	12·35	9 8	11·2	12·2	13·0

(6) The shape of the forehead; and

(7) The form and size of the mastoid process of the periotic.

Although the conclusion arrived at is, that it is impossible to separate *U. horribilis* (*ferox*) from *U. arctos* by the study of the skeleton, it has been thought advisable in the tables of comparative measurements to quote without comment the name previously assigned to any specimen.

B. Dentition (Plate VI).

(1) *Distinctive Features of the Teeth in the Genus Ursus.*—The dental formula is i. $\frac{3}{3}$, c. $\frac{1}{1}$, pm. $\frac{4}{4}$, m. $\frac{2}{3}$, as in the dog. In *Hyæna* it is i. $\frac{3}{3}$, c. $\frac{1}{1}$, pm. $\frac{4}{3}$, m. $\frac{1}{1}$, and in *Felis* i. $\frac{3}{3}$, c. $\frac{1}{1}$, pm. $\frac{3}{2}$, m. $\frac{1}{1}$. Although the upper incisors increase somewhat in size from the first to the third, *Ursus* agrees with *Felis* and differs from *Hyæna* in presenting a marked contrast in size between $\underline{\text{c.}}$ and $\underline{\text{i 3}}$. The canine is distinguished from that of the lion by the more massive character of the root. The three anterior premolars above and below are very small, one-rooted, and often early deciduous, especially the second, which is rarely present in the adult animal. $\underline{\text{Pm. 1}}$ is situated close to the canine, $\underline{\text{pm. 3}}$ close to $\underline{\text{pm. 4}}$, which is the upper carnassial. This tooth lacks the antero-internally placed inner tubercle supported by a distinct root, which is so characteristic of *Felis*, *Hyæna*, and *Canis*. $\underline{\text{Pm. 4}}$ possesses, however, a postero-internally placed inner cusp which, as in other Ursidæ, is not supported by a distinct root. The sectorial characters of $\underline{\text{pm. 4}}$ are very little marked, and it is much smaller than $\underline{\text{m. 1}}$. The crowns of both the upper true molars are longer than broad, and have flattened tuberculated grinding surfaces; the second has a large backward prolongation or heel. The lower carnassial ($\overline{\text{m. 1}}$) has a small and indistinct blade and a greatly developed tubercular heel. The second molar is of about the same length as the carnassial, but with a broader and more flattened tubercular crown. The third is smaller. The milk-teeth are comparatively simple and shed at an early age.

The following descriptions are of teeth of *Ursus spelæus*, but in each case the differences presented by the teeth of bears of the *arctos* type are noted.

It has been thought best when describing the teeth not to use terms involving assumptions of homology and requiring long explanatory prefixes. The terms *cusp* and *tubercle* are regarded as synonyms for small elevations on the surface of a tooth. The terms *cone* or *lobe* are used as denoting a rather larger elevation, and the terms *talon* or *heel* for posteriorly placed segments of a tooth.

(2) *Permanent Dentition of the Upper Jaw* (see Pl. VI).—$\underline{\text{I. 1 and 2}}$ are very similar teeth showing a prominent anterior, pointed, and somewhat backwardly directed cone or cusp, and a depressed triangular posterior area not bearing any

definite cusp. The marginal portion of the triangular area is slightly raised. The root, which in each case is rather more than twice as long as the crown, is considerably laterally compressed.

In bears of the *arctos* type the posterior area is more sharply marked off from the cone than in the cave bear.

I. 3 is a larger and more caniniform tooth, with a prominent, sharply reflected cone. There is no depressed posterior area as in I. 1 and 2, but a slight cusp is developed on the inner side, and from it a cingulum extends along the inner and posterior margin of the crown. The root is not so much laterally compressed as in I. 1 and 2.

In bears of the *arctos* type this tooth differs only in size and in the slight development of the cingulum.

C. The canine has the form usually met with in Carnivora. Its crown constitutes about one third of its length, and is frequently, though not invariably, marked by a wide, shallow groove along its inner face, and by a slight ridge along its posterior face. The crown is slightly longer and more recurved and pointed than in *Hyæna*, and the root tapers more than in that animal, and is more massive than in *Felis*. Size constitutes the only difference between the canine of the cave bear and that of bears of the *arctos* type.

Pm. 1 and 2, which are almost invariably absent in the cave bear and irregular in their occurrence in bears of the *arctos* type, are small and simple teeth, with a low crown and long cylindrical root.

Pm. 3, which is absent as a rule in the cave bear, is in bears of the *arctos* type a small tooth with well-developed cone and slight indications of anterior and posterior cusps. The cingulum is slightly developed on the inner side.

Pm. 4, the upper carnassial, has the blade divided into a prominent anterior cone (*a*)[1] and a less elevated posterior cone (*b*), behind which is commonly a slight additional cusp. Lying postero-internally to the blade is a large inner cone or lobe (Pl. VI, fig. 1, *c*), which shows considerable variation. The cingulum is often strongly marked, especially antero-internally. There are two roots, a smaller anterior one supporting the anterior cone of the blade, and a larger posterior one supporting the posterior cone of the blade and the inner lobe.

In bears of the *arctos* type the cingulum is not so strongly marked, the inner cone or lobe tending to be relatively larger than in *U. spelæus*, and often having a slight additional cusp cut off from its posterior edge, sometimes also from its anterior edge. This inner cone or lobe, which is posteriorly placed, must not be confused with the inner tubercle characteristic of the upper carnassial in *Felis*, *Canis*, and *Hyæna*, which is anteriorly placed.

M. 1 has a large, somewhat quadrangular crown with the surface raised into

[1] This and the following letters refer to Plate VI.

a double row of low cusps lying along the inner and outer edges of the tooth. Of the four cusps along the outer border, the anterior and posterior are very small, the second from the anterior end being the largest. The cingulum is well marked along the inner surface. The tooth is fixed in the jaw by three roots, one lying internally and the other two antero- and postero-externally.

In bears of the *arctos* type the cingulum is less marked, and the two principal cusps along the outer border do not appreciably differ in size.

$\underline{\text{M. 2}}$ is the largest tooth belonging to the molar series. The grinding surface is completely tuberculated, the two most prominent cusps or elevations (*d*) occupy the anterior half of the outer border, and behind them a third and much smaller cusp is often found. The anterior cusp tends to be the largest. There are four roots, one placed anteriorly, one near the middle of the outer surface, one postero-internally, and one on the inner surface near the anterior end.

In bears of the *arctos* type the two antero-external cusps tend to be equal in size, and the tooth to narrow posteriorly more than in the cave bear. These distinctions, however, do not always hold, and are of little practical value.

(3) *Permanent Dentition in the Lower Jaw* (see Pl. VI).—$\overline{\text{I. 1}}$ is a small tooth with both root and crown much laterally compressed. The crown forms a single very slightly recurved cone, with a small tubercle on the outer side. I can detect no valid difference in bears of the *arctos* type.

$\overline{\text{I. 2}}$ has the root similar to that of $\overline{\text{I. 1}}$, but the crown is not so much compressed and the tubercle on the outer side is larger and placed lower down the crown than in $\overline{\text{I. 1}}$. There is also an indication of a tubercle on the inner side of the crown, while from each tubercle a slight ridge runs downwards and backwards to meet its fellow at the base of the crown.

In bears of the *arctos* type the outer tubercle is relatively more prominent than in *U. spelæus*, while the inner tubercle and pair of downwardly and backwardly directed ridges are not present.

$\overline{\text{I. 3}}$ is a slightly larger tooth with the root triangular in section, the apex of the triangle being directed backwards. The outer tubercle (Pl. VI, fig. 2, *e*) is very prominent and sharply divergent from the crown. A slight ridge passes backwards and downwards from it to meet another bounding the inner side of the crown. In bears of the *arctos* type the tooth differs only in its smaller size, and in the slighter development of the ridges.

$\overline{\text{C.}}$ This tooth differs from the corresponding one in the upper jaw in having sometimes at any rate, both crown and terminal part of the root slightly inwardly inflected on the main part of the tooth. The smaller size is the only respect in which $\bar{\text{c}}$. of bears of the *arctos* type differs from the corresponding tooth of the cave bear.

$\overline{\text{Pm. 1, 2, 3}}$, which are absent as a rule in the cave bear, are all small conical

teeth with low crowns and rather long cylindrical roots, $\overline{\text{pm. 1}}$ being the largest and the one which most commonly persists.

$\overline{\text{Pm. 4}}$ is a small tooth showing much variation. As a rule, in addition to the principal cone, one or more of three little cusps may be developed, two placed respectively at the antero-internal (Pl. VI, fig. 6, 1) and postero-internal (Pl. VI, fig. 6, 3) edges, and the third (Pl. VI, fig. 6, 2) slightly behind and to the inner side of the principal cone.

In bears of the *arctos* type the development of inner cusps is not so great as in the cave bear, and in many cases the tooth is entirely without them.

$\overline{\text{M 1.}}$ This is an elongated tooth, divided by a constriction into a posterior square portion (*g*) whose length is about one third of that of the entire tooth, and an anterior more elongated portion. The posterior portion, which represents the greatly enlarged heel or talon of the corresponding tooth in *Canis*, has the surface raised into a series of low cusps, the two most marked of which lie on the inner border and are nearly equal in size. The anterior portion generally shows two prominent cusps, one forming the anterior extremity of the crown, one farther back and on the outer side of the tooth. There are several smaller and generally ill-defined cusps along the inner border. Each portion of the tooth is supported by a strong root. The angle of divergence between the two roots varies much.

In bears of the *arctos* type the constriction between the two portions of the tooth is not so marked as in the cave bear, and the cusps are less prominent. The hinder of the two, lying on the inner border of the posterior square portion of the tooth, tends to be larger than the anterior. The cusp forming the anterior end of the tooth is less marked than in the cave bear, and often has a small accessory cusp on its inner side.

$\overline{\text{M. 2.}}$ The sides of this tooth are parallel, and the length is nearly twice the breadth. A slight constriction divides the tooth into anterior and posterior halves. The surface is somewhat uniformly tuberculated, the greatest elevation lying antero-internally. The tooth is fixed in the jaw by two stout roots, the posterior being the larger.

I cannot detect any difference from the above in teeth of bears of the *arctos* type.

$\overline{\text{M. 3.}}$ The crown, which has parallel sides, is slightly rounded in front and more markedly rounded behind. The length as compared with the breadth is about 5—4. The posterior border is sometimes rounded, sometimes more or less obliquely truncated externally. The surface of the crown is very uniformly covered with low tubercles (Pl. VI, fig. 5), the largest being placed at the antero internal angle. There are three roots, one placed anteriorly and two posteriorly, but all three roots sometimes coalesce.

In bears of the *arctos* type the tooth is rather longer in proportion to its width

than in the cave bear, and is as a rule rather more contracted posteriorly. The surface of the crown tends to be ridged rather than tuberculated.

It proved impossible to obtain anything approaching a complete series of milk-teeth, and it therefore seemed best not to attempt a description of them.

(2) Table of Measurements of the Series of Permanent Teeth from Torbryan, near Torquay, figured on Plate VI.

	$\text{i. 1}\rvert$	$\text{i. 2}\rvert$	$\text{i. 3}\rvert$	$\text{c.}\rvert$	$\text{pm. 3}\rvert$	$\text{pm. 4}\rvert$	$\text{m. 1}\rvert$	$\text{m. 2}\rvert$	$\lvert\text{i. 1}$	$\lvert\text{i. 2}$	$\lvert\text{i. 3}$	$\lvert\text{c.}$	$\lvert\text{pm. 4}$	$\lvert\text{m. 1}$	$\lvert\text{m. 2}$	$\lvert\text{m. 3}$
1. Antero-posterior extent at base of crown	1·0	1·1	1·1	2·1	0·75	2·0	2·5	3·95	0·9	0·9	0·95	2·1	1·55	2·7	3·05	2·55
2. Maximum transverse measurement	0·9	0·9	1·05	1·6	0·55	1·5	1·8	1·9	0·5	0·75	1·05	1·4	0·95	1·2	1·8	1·85
3. Maximum length measured along a straight line from root to crown	2·9	3·0	3·7	8·9	...	...	...	...	2·9	3·3	3·4	8·25	...	...	...	...

c. The Vertebral Column (Plates VII, VIII).

The vertebral column of bears shows few characters distinguishing it from that of other Carnivora. Probably the most noteworthy feature is the tendency to ankylosis in the sacral region in old animals, which may have as many as five sacral and pseudo-sacral vertebræ (see Text-fig. 1, p. 19). There are fourteen thoracic and six lumbar vertebræ as compared with thirteen thoracic and seven lumbar in *Felis, Canis and Viverra*, and fifteen thoracic and five lumbar in *Meles*.

(3) Tables of Comparative Measurements of Bear Vertebræ.

	U. spelæus, Banwell (Taunton Mus.).	*U. horribilis*, Sandford (Taunton Mus.).	*U. horribilis*, No. 854 (College of Surgeons).	*U. arctos*, No. 218 *d* (Brit. Mus.).
Atlas.				
1. Maximum width	...	...	17·3	19·6
2. Median dorso-ventral diameter	...	5·2[1]	4·4	5·35
3. Extreme width of the condylar articular surfaces	...	8·1	6·5	8·2
4. Maximum width of neural canal	...	3·55	3·1	4·0
Axis.				
1. Length from anterior end of odontoid process to postero-ventral extremity of centrum	8·9	8·15[1]	6·9	8·1
2. Height from roof of neural canal to top of neural spine	6·35	3·55	4·2	4·4
3. Transverse diameter across prezygapophyses	8·4	6·85	5·6	6·8
4. Transverse diameter across postzygapophyses	7·65	5·5	5·35	5·9
5. Length from anterior end of neural spine to notch between postzygapophyses	6·3	6·7	6·1	7·1

[1] Figured.

COMPARATIVE MEASUREMENTS OF BEAR VERTEBRÆ (*continued*).

	3rd cervical.		4th cervical.		5th cervical.	
	U. horribilis, No. 854 (College of Surgeons).	*U. arctos*, No. 218*d* (Brit. Mus.).	*U. horribilis*,[1] Sandford (Taunton Museum).	*U. arctos*, No. 218*d* (Brit. Mus.).	*U. horribilis*, No. 854 (College of Surgeons).	*U. arctos*, No. 218*d* (Brit. Mus.).
1. Maximum length of centrum... measured from dorso-anterior to ventro-posterior edge	4·75	4·8	4·5	4·55	4·35	5·0
2. Width across transverse processes	10·7	12·6	...	13·35	12·5	13·3
3. Width across postzygapophyses	6·0	6·25	7·8	6·95	6·35	7·0
4. Height from roof of neural canal to top of neural spine	2·15	1·35	...	4·4	3·7	4·45

[1] Figured.

	6th cervical.		7th cervical.		
	U. horribilis, No. 854 (College of Surgeons).	*U. arctos*, No. 218*d* (Brit. Mus.).	*U. horribilis*,[1] Sandford (Taunton Museum).	*U. horribilis*, No. 854 (College of Surgeons).	*U. arctos*, No. 218*d* (Brit. Mus.).
1. Maximum length of centrum from dorso-anterior to ventro-posterior edge	4·3	5·0	...	4·0	4·5
2. Length from dorso-anterior to dorso-posterior edge of centrum..............................	3·2	3·7	3·15	2·95	...
3. Width across transverse processes	11·6	12·95	...	12·0	12·15
4. Width across postzygapophyses	6·15	6·45	7·0	6·3	6·7
5. Height from roof of neural canal to top of neural spine	3·6	4·85	11·4	4·6	6·6

[1] Figured.

Comparative Measurements of Bear Vertebræ (*continued*).

	1st thoracic.		2nd thoracic		3rd thoracic.	4th thoracic.
	U. horribilis, Sandford (Taunton Museum).	*U. arctos*, Burwell Fen (Sedgwick Museum).	*U. horribilis*, Sandford (Taunton Museum).	*U. arctos*, Burwell Fen (Sedgwick Museum).	*U. arctos*, Burwell Fen (Sedgwick Museum).	*U. arctos*, Burwell Fen (Sedgwick Museum)
1. Length from dorso-anterior to dorso-posterior edge of centrum	3·1 [1]	2·9	3·15 [1]	2·65	2·8 [1]	2·9
2. Width across postzygapophyses	6·55	4·35	4·7	3·45	3·1	3·0
3. Width across transverse processes ...	12·8	10·0	11·0	8·85	8·4	8·25
4. Length of neural spine from notch between prezygapophyses	...	6·9	...	8·35	8·2	8·35

	5th thoracic.		6th thoracic.		13th thoracic.	14th thoracic.
1. Maximum length of centrum	...	3·0 [1]	...	3·0	3·95	4·1 [1]
2. Width across transverse processes ...	...	7·75	...	7·9	...	...
3. Length of neural spine from notch between prezygapophyses	...	8·45	...	8·55	4·45	4·5

[1] Figured.

	2nd lumbar	3rd lumbar		4th lumbar.	5th lumbar.	6th lumbar.
	U. arctos, Burwell Fen (Sedgwick Museum).	*U. horribilis*, Sandford (Taunton Museum).	*U. arctos*, Burwell Fen (Sedgwick Museum).	*U. arctos* Burwell Fen (Sedgwick Museum).	*U. arctos*, Burwell Fen (Sedgwick Museum).	*U. arctos*, Burwell Fen (Sedgwick Museum).
1. Maximum length of centrum	4·35	4·45 [1]	4·35	4·45	4·45	4·0
2. Width across processes bearing pre-zygapophyses	5·5	8·3	5·8	5·45	5·9	6·35
3. Height of neural spine from notch between postzygapophyses............	4·8	6·5	5·15	5·25	5·1	4·4
4. Width across transverse processes ...	11·4	...	13·0	14·7	14·3	13·4

[1] Figured.

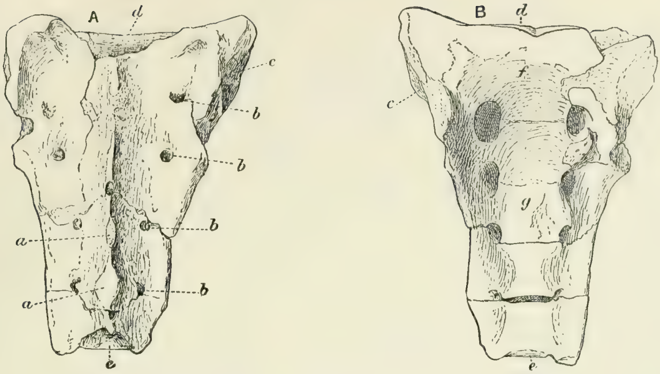


FIG. 1.—A dorsal, B ventral view of a sacrum (No. 48827), from Brixham, preserved in the British Museum; *a*, neural spine; *b*, foramen for exit of spinal nerve; *c*, articular surface for ilium; *d*, anterior face of centrum of first sacral vertebra; *e*, posterior face of centrum of third caudal or pseudosacral vertebra; *f*, ventral surface of centrum of first sacral vertebra; *g*, ventral surface of centrum of first caudal or pseudosacral vertebra.

D. THE SHOULDER GIRDLE.

The scapula in bears (Text-fig. 2) does not present any features of special interest. The British fossil specimens are almost invariably in a very fragmentary state.

(4) TABLE OF MEASUREMENTS OF THE SCAPULA.

	U. horribilis, No. 854 (R. Coll. of Surgeons Mus.).	*U. arctos*, No. 218 *d* (Brit. Mus.).
1. Length along line of spine measured from acromion	26·6	31·85
2. Maximum width	20·1	23·8
3. Maximum length of glenoid cavity	5·95	6·1
4. Height from top of acromion to inner edge of glenoid cavity	8·35	10·9
5. Length from end of coracoid process to surface of bone behind glenoid cavity	7·35	...

E. THE ANTERIOR LIMB.

The humerus (Text-fig. 3) has a strong deltoid ridge. A supra-condylar foramen is not present.

Fig. 2.—Articular view of a portion of the left scapula (N.H. 93), from the Newhall Caves, Edenvale, Co. Clare, now preserved in the National Museum, Dublin. *a*, glenoid cavity; *b*, acromion.

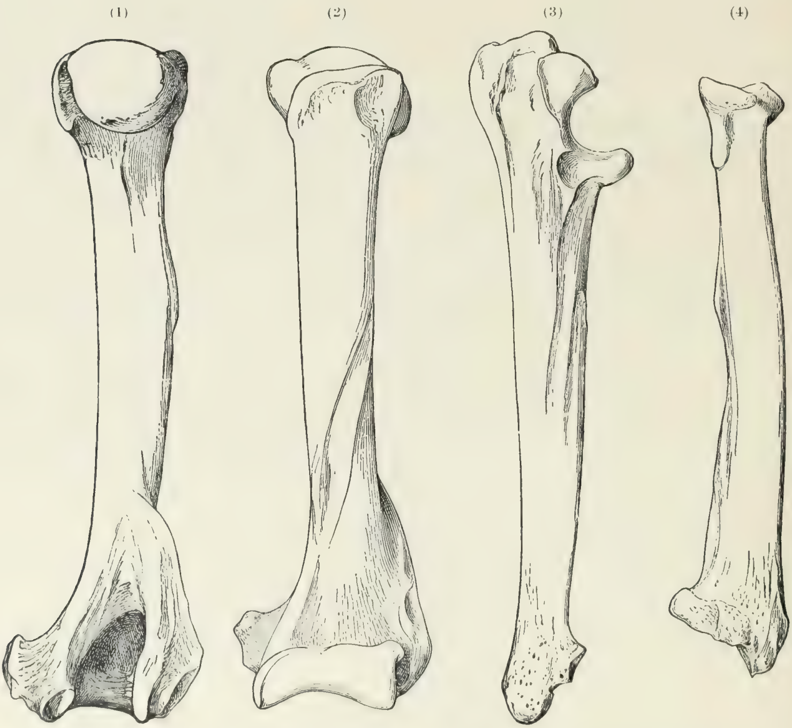


Fig. 3.—(1) Back view of right humerus, Sandford (Taunton Mus.). (2) Front view of left humerus, Grays, Essex (Brit. Mus.). (3) Antero-internal view of right ulna, Sandford (Taunton Mus.). (4) Front view of right radius, Sandford (Taunton Mus.). All the above specimens are attributed to *Ursus horribilis*, and are drawn $\frac{1}{3}$ natural size.

(5) Table of Comparative Measurements of Bones of Anterior Limb.

	U. spelæus, Banwell (Taunton Mus.).	*U. spelæus*, Sandford (Taunton Mus.).	*U. ferox fossilis* = *horribilis*, Grays, Essex, No. 21287 (Brit. Mus.).	*U. arctos*, No. 218*a* (Brit. Mus.).	*U. horribilis*, No. 854 (R. Coll. of Surgeons Mus.).
Humerus.					
1. Extreme length	...	...	[3]37·3[1]	39·15[1]	34·0
2. Diameter of proximal end passing across centre of articulating surface and greater tuberosity	...	...	9·0	8·15	8·3
3. Vertical diameter of shaft at middle of deltoid ridge	6·35[1]	[3]6·8[2]	4·4	4·95	3·8
4. Transverse diameter at same point	5·5	5·85	3·9	4·05	3·7
5. Maximum transverse diameter at distal end	16·8	16·75	11·3	10·8	...
6. Maximum width of trochlea	...	...	...	...	7·1
Radius.					
1. Extreme length	42·4[1]	[3]37·8[2]	...	33·9[1]	30·3[2]
2. Right and left or transverse measurement at humeral articulation	5·55	6·1	...	4·6	4·1
3. Antero-posterior or vertical measurement at humeral articulation	4·4	4·8	...	3·65	3·05
4. Transverse diameter at carpal articulation	8·1	9·2	...	6·85	5·9
5. Vertical diameter at carpal articulation	4·8	5·45	...	4·4	3·5
6. Transverse diameter at middle of shaft	5·1	5·3	...	2·9	...
7. Vertical diameter at middle of shaft	2·8	2·5	...	2·1	...

[1] Left. [2] Right. [3] Figured.

	U. spelæus, Banwell (Taunton Mus.).	*U. horribilis*, Kew Bridge, No. 24361 (Brit. Mus.).	*U. ferox fossilis* = *horribilis*, Ilford, No. 38512 (Brit. Mus.).	*U. horribilis*, No. 854 (R. Coll. of Surgeons Mus.).	*U. arctos*, No. 218*a* (Brit. Mus.).
Ulna.					
1. Extreme length	46·5	44·0	38·6[1]	34·15	38·45[1]
2. Antero-posterior or vertical measurement at distal end of sigmoid notch	10·3	9·35	7·7	6·4	7·3
3. Maximum transverse measurement of olecranon	10·7	9·75	8·25	6·8	7·8
4. Transverse diameter at carpal articulation	3·4	3·25	3·0	2·2	2·1
5. Vertical diameter at carpal articulation	4·8	...	4·8	3·9	3·9
Length of 1st metacarpal	...	...	...	...	8·1
„ 2nd „	...	...	...	...	8·8
„ 3rd „	...	...	...	...	9·0
„ 4th „	...	...	...	...	9·3
„ 5th „	...	...	...	...	9·4

[1] Left.

F. The Pelvic Girdle.

This is characterised by the shortness of the ilia and their evertion above. The British fossil specimens are almost always in a very fragmentary state.

(6) Table of Comparative Measurements.

	U. horribilis, No. 854 (R. Coll. of Surgeons Mus.).	*U. arctos*, No. 218*d* (Brit. Mus.).
Innominate Bone.		
1. Maximum length	31·85	37·5
2. Length from edge of acetabulum to dorsal or anterior border of ilium	15·1	18·65
3. Vertical measurement of ilium at widest point	12·1	14·7
4. Thickness of ilium at middle of surface	...	...
5. Antero-posterior diameter of acetabulum	5·05	5·3
6. Length from acetabulum to posterior border of ischium	11·25	11·7
7. Maximum diameter of obturator foramen	8·2	...
8. Measurement along ischium from symphysis to end of ischial spine	12·2	16·9

Fig. 4.—Ventral view of left innominate bone (N.H. 197), from the Newhall Caves, Edenvale, Co. Clare, preserved in the National Museum, Dublin ($\frac{1}{3}$ nat. size). *a*, ilium; *b*, ischium; *c*, pubis; *d*, acetabulum; *e*, obturator foramen.

G. The Posterior Limb.

This, as noted by Gaudry and Boule, tends to be somewhat shorter in proportion to the size of the animal in *U. spelæus* than in the bears of the *arctos* type.

The tibia is specially short, and Gaudry and Boule have suggested that this is perhaps a disposition favourable for descending into the caves in which the animal lived. Owen[1] attempts to discriminate between the femur of the different species of fossil

Fig. 5.—(1) Front view and (2) right side view of left femur attributed to *U. horribilis*, from Sandford (Taunton Mus.) ($\frac{1}{3}$ nat. size).

bears. He says that in the brown and grizzly bears the femur is broader in proportion to its length, and the tuberosity above the internal condyle is larger than in the cave bear. He also states that in the cave bear the lesser trochanter projects a little beyond the inner margin, while in the grizzly and brown bears it is thrown wholly on the posterior surface of the bone.

[1] 'Brit. Foss. Mamm.,' p. 97.

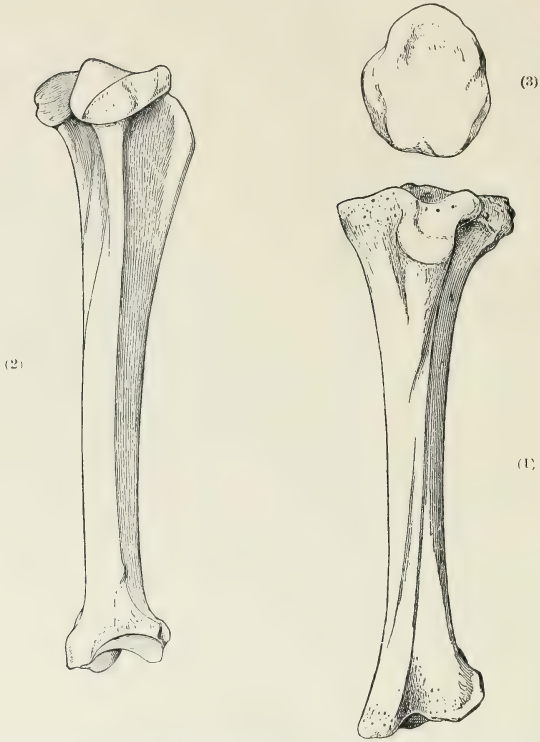


Fig. 6.—(1) Front view of right tibia, from Sandford (Taunton Mus.). (2) Postero-external view of right tibia, from Ilford, Essex (Brit. Mus.). (3) Patella, from Banwell (Taunton Mus.). All are drawn $\frac{1}{3}$ natural size. The patella is attributed to *U. spelæus,* the tibiæ to *U. horribilis.*

(7) Table of Comparative Measurements of Bones of Posterior Limb.

	U. horribilis, Sandford (Taunton Mus.).	*U. horribilis,* Sandford (Taunton Mus.).	*U. horribilis,* No. 854 (R. Col. of Surgeons Mus.).	*U. arctos* No. 218*a*, (Brit. Mus.).
Femur.				
1. Maximum length	[3]52·5[1]	...	40·2[2]	46·0[1]
2. Transverse diameter at condyles	11·5	11·7[2]	7·3	8·3
3. Antero-posterior diameter of head	5·6	...	4·5	4·85
4. Vertical or antero-posterior diameter of shaft at middle	4·0	4·3	2·8	2·95
5. Transverse or right to left diameter of shaft at middle	5·0	5·2	3·4	4·85
6. Transverse diameter at proximal end measured across head and great trochanter	13·45	...	9·8	...

[1] Left. [2] Right. [3] Figured.

Table of Comparative Measurements—*continued.*

	U. horribilis, Sandford (Taunton Mus.).	*U. horribilis*, Sandford (Taunton Mus.).	*U. ferox fossilis* = *horribilis*, Ilford, No. 44928 (Brit. Mus.).	*U. horribilis*, No. 854 (R. Col. of Surgeons Mus.).	*U. arctos*, No. 218*a* (Brit. Mus.).
Tibia.					
1. Maximum length	36·5	31·5 [2]	34·25 [1]	28·9 [2]	33·2
2. Transverse or right to left diameter at proximal end	11·35	9·85	8·9	7·9	8·25
3. Vertical or antero-posterior diameter at proximal end measured from notch between articulating surface for femur and top of crest	7·3	...	8·3	6·55	6·95
4. Transverse diameter at distal end	8·1	7·1	5·95	6·45	6·7
5. Vertical diameter at distal end measured across elevation between articular faces for calcaneum	5·1	4·25	...	2·95	...
6. Transverse diameter at narrowest part of shaft	4·0	3·5	3·0	2·45	2·65

[1] Figured. [2] Right.

	U. horribilis, Sandford (Taunton Mus.)	*U. horribilis*, Sandford (Taunton Mus.).	*U. horribilis*, No. 854 (R. Col. of Surgeons Mus.).	*U. arctos*, No. 218*a* (Brit. Mus.).
Fibula.				
1. Maximum length	27·2	...	26·25	30·45
2. Transverse diameter at distal end	1·7	2·85 [2]	2·7	...
3. Vertical diameter at distal end	3·4	3·8	1·45	2·6
4. Transverse diameter at proximal end	1·75	...	1·7	...
5. Vertical diameter at proximal end	2·5	...	2·05	...
Calcaneum.				
1. Length	11·25	11·4	8·3	9·1
2. Maximum transverse diameter	7·15	7·5	5·7	5·55
Astragalus.				
Right to left diameter	8·8	...	5·3	4·6
Metatarsals.				
Length of 1st metatarsal [1]	...	...	6·45	7·2
„ 2nd „	...	...	7·25	8·65
„ 3rd „	...	...	7·3	9·05
„ 4th „	...	...	8·3	10·25
„ 5th „	...	...	8·8	10·5

[1] All measured along plantar surface. [2] A large bone lacking proximal end.

IV. COMPARISON OF THE CAVE, BROWN, AND GRIZZLY BEARS.

The subject of the mutual relations of the Pleistocene bears is one of very great difficulty, and very varying opinions have been expressed as to the number of species. Most palæontologists have recognised three species, viz., *U. spelæus*, *U. horribilis* (= *ferox*, = *ferox fossilis*, = *priscus*), and *U. arctos*. Owen, Busk, Boyd

Dawkins (previous to 1877), Lydekker (when writing in 1885), Woodward and Sherborn, adopt the above three-fold division of the Pleistocene bears.

With very few exceptions palæontologists have considered *U. spelæus* to be distinct from the rest, but as early as 1844 de Blainville expressed doubts on this head, considering that the differences between the fossil bears were merely racial. Adams too, in 1880 and also in 1881, suggested that the bones attributed to *U. spelæus* might be only those of larger individuals of the same species as *U. ferox*, and that all the British fossil bears might be regarded as races of one species.

Comparison of the Cave Bear with Bears of the *arctos* Type.

The following characters have been quoted by various palæontologists, principally Owen,[1] Busk,[2] and Lydekker,[3] as distinguishing the cave bear from those of the *arctos* type:

(*a*) *Distinguishing Characters drawn from the Teeth.*

Cave Bear.	Bears of *arctos* Type.
(1) The three anterior premolars of both jaws are generally lost very early, all traces of their alveoli commonly disappearing.	The three anterior premolars, especially pm. 1 and pm. 3 of both jaws are far more persistent.

The complete loss of the three anterior premolars is undoubtedly almost or quite universal in the large cave bear skulls, but is not universal in the case of smaller individuals attributed to the cave bear. Thus Gaudry and Boule[4] have shown that in the small race from Gargas $\underline{\text{pm. }3}$ is not always lost, and Owen[5] mentions a jaw from Torquay which retains $\overline{\text{pm. }1}$. Newton[6] too attributes to *U. spelæus* a small jaw from the Forest Bed in spite of the retention of $\overline{\text{pm. }1}$.

Cave Bear.	Bears of the *arctos* Type.
(2) $\underline{\text{M. }2}$. has a more or less oblong form, the sides being nearly parallel, and the hind end not much narrower than the middle, and never or hardly ever pointed. The grinding surface when unworn is comparatively flat. On the outer border are three cusps of which the hindmost is very low and soon worn off (Busk).	$\underline{\text{M. }2}$ is more constricted behind, and the grinding surface of the unworn tooth is more compressed from side to side than in *U. spelæus*. Of the three outer cusps the two anterior are more nearly equal in size than in *U. spelæus* (Busk).

[1] 'Brit. Foss. Mamm. and Birds,' p. 86, *et seq.*

[2] 'Trans. Zool. Soc.,' x, 1877, p. 60.

[3] 'Palæont. Indica,' ser. 10, vol. ii, p. 210; and 'Proc. Zool. Soc.,' 1897, pp. 412—426.

[4] 'Matériaux pour l'histoire des temps quaternaires,' p. 109.

[5] 'Brit. Foss. Mamm. and Birds,' p. 91.

[6] "Vert. of Forest Bed" ('Mem. Geol. Surv.'), p. 5.

I cannot detect any constant differences between $\underline{\text{m. 2}}$ in the two cases, though in some instances there is a tendency for the crown of the tooth to show less posterior contraction in the cave bear than in the others.

Cave Bear.

(3) In $\overline{\text{pm. 4}}$ besides the principal cone there are usually on the inner side two and always one smaller cusp, of which one is anterior in position to the principal cusp (Busk). Hensel[1] and Owen make similar statements, and Owen also mentions a ridge extending along the outer and back part of the base of the crown as characteristic. Lydekker[2] says $\overline{\text{pm. 4}}$ is relatively short, the inner tubercles are very large and the first is placed more on the inner side than in *U. arctos*.

Bears of *arctos* Type.

$\overline{\text{Pm. 4}}$ has either only the principal cusp or at most a very small internal tubercle corresponding to the hinder of those met with in *U. spelæus* (Busk).

It is undoubtedly the fact that there is a greater development of accessory tubercles in the case of the tooth in the cave bear than in bears of the *arctos* type, and this tooth probably affords better characters for the separation of the cave bear than any other part of the skeleton. An examination of a large series of skulls, recent and fossil, of bears of the *arctos* type, shows that although very often $\overline{\text{pm. 4}}$ is without any internal cusps or possesses only one small one, and though they never show the development that occurs in *U. spelæus*, yet that in some cases two or even three may be present. Further information with regard to the development of these cusps is given in the table on p. 31 ; cf. also Pl. VI, fig. 6.

Cave Bear.

(4) $\overline{\text{M. 3}}$ is broader in proportion to its length than in bears of the *arctos* type. The outer surface is divided into two distinct but low cusps by a deep sulcus. The grinding surface is minutely tuberculated (Busk) (*cf.* Pl. VI, fig. 5 *a*).

Bears of *arctos* Type.

$\overline{\text{M. 3}}$ is subtriangular and narrower behind than in *U. spelæus*. In typical examples there is no sulcus on the outer border. The grinding surface is coarsely ridged, not tuberculated (Busk) (*cf.* Pl. VI, fig. 5 *b*).

Great stress is laid especially by Busk on the structure of this tooth. It is certainly somewhat broader in proportion to its length in the cave bear than in bears of the *arctos* type. While no example of $\overline{\text{m. 3}}$ from a bear of the *arctos* type

[1] 'Sitzb. Naturf. Freunde Berlin,' 1876, p. 49.

[2] 'Proc. Zool. Soc.,' 1897, pp. 412—426.

was met with showing the peculiar uniform tuberculation of some of the cave bear specimens, some of the small mandibles attributed to this species have the surface of $\overline{\text{m. 3}}$ wholly or partially ridged as in bears of the *arctos* type.

(5) Boyd Dawkins[1] states that the canine is on the whole more massive in the cave bear than in the grizzly, especially as regards the root. "It is also generally but not always absolutely larger in the crown, as Prof. Busk has remarked in his description of the teeth from the Brixham Cave."

(*b*) *Distinguishing Characters drawn from Parts other than the Teeth.*

(1) *The relatively enormous size of the cave bear.*—The size of the cave bear's skull, though as a rule much greater than that of the fossil representatives of the brown and grizzly bears, is not so much greater than that of the huge grizzlies of Alaska and brown bears of Kamtchatka. Also, as pointed out by Owen, a mandible from the Forest Bed which he figures,[2] and which on account of the complete absence of the anterior premolars he attributes to *U. spelæus*, is a good deal smaller than a second mandible from Manea fen, which, owing to the large alveoli for $\overline{\text{pm. 1, 3}}$, he regards as belonging to *U. arctos*.

(2) *The relatively great length of the interspace between* $\underline{\text{c}}$. *and* $\underline{\text{pm. 4}}$ *in the cave bear.*—This certainly is subject to a very large amount of variation, as the table of measurements on p. 11 shows (*cf.* also Pl. V). Busk says it is a feature distinguishing the cave from the brown bear but not from the grizzly. Owen quotes it as also distinguishing the cave bear from the grizzly.

(3) *The relative narrowness of the posterior narial opening in the cave bear.*—This, again, is a feature showing much variability (see the measurements on p. 11).

(4) *The arched character of the frontal region in the cave bear's skull.*—In many of the huge skulls from French, German, and Belgian caves this is very marked, the skull rising into two considerable bosses at the junction of the frontals and nasals owing to the enlargement of the frontal sinuses. In some of the smaller cave bear skulls, on the other hand, it is scarcely more noticeable than in those of the brown and grizzly bears. It is probably a character which increased with age and became specially marked in the old males. Owen refers to de Blainville's suggestion, that the development of the frontal sinuses depended on the cave bear's breathing a fresher, dryer, and more invigorating atmosphere than its present-day allies.

(5) *The rapid approach of the temporal crests so as to form an obtuse angle posteriorly.*

[1] 'Quart. Journ. Geol. Soc.,' xxxi, 1875, p. 251.

[2] 'Brit. Foss. Mamm. and Birds,' p. 106.

(6) *The convex character of the lower jaw* (Owen and Falconer).—Neither of the characters 5 or 6 seems to be constant.

(7) *The relative shortness of the limb bones, especially of the tibia in the cave bear* (Gaudry and Boule).—This appears to be a constant character.

(8) *The relative weakness of the hind limbs* (Gaudry and Boule).—Gaudry and Boule's suggestion in this connection has been referred to on p. 22.

(9) *The relative narrowness of the femur in proportion to its length, the small size of the tuberosity above the internal condyle, and the projection of the lesser trochanter a little beyond the inner margin in the cave bear* (Owen).

Comparison of the various Bears of the *arctos* Type.

With regard to the distinction between the brown and grizzly bears, there is by no means such a consensus of opinion as there is concerning the distinction of the cave bear. Not only de Blainville (1844), but Middendorff (1851), Müller (1872), Busk (1873), Boyd Dawkins (1877), Lydekker (1884 and 1885), and Brown (1894), doubt whether the brown and grizzly bears can be separated from one another.

The points of difference, whether valid or otherwise, have been noted as follows, and are mainly due to Owen and Busk.[1]

	U. arctos.	*U. horribilis.*
1.	$\underline{\text{m. 2}}$. The unworn crown is much compressed; there are only two cusps on the outer border of the tooth, of which the anterior is considerably the larger, and the posterior has in most cases a small portion in front constricted off so as to form an accessory tubercle between the two cusps (Busk).	The unworn crown is less compressed, and there are occasionally three outer cusps; the anterior two are more nearly equal in size than *U. arctos*, and the third is always small and often wanting. There is no accessory tubercle cut off from the anterior border of the posterior cusp (Busk).
2.	$\underline{\text{pm. 4}}$ tends to be relatively long.	$\underline{\text{pm. 4}}$ tends to be relatively shorter, and there is more of a shelf-like projection of the cingulum at the antero-internal corner (Brown).[2]
3.	There is a relatively narrow space between $\underline{\text{c}}$. and $\underline{\text{pm. 4}}$.	There is a relatively wide space between $\underline{\text{c}}$. and $\underline{\text{pm. 4}}$.
4.	The inner posterior cusp or tubercle of $\overline{\text{pm. 4}}$ is very small or absent, and if present there is no bifid posterior talon projecting from it (Busk).	The inner posterior cusp of $\overline{\text{pm. 4}}$ is better developed than in *U. arctos*, and the posterior talon is commonly bifid or marked by two longitudinal ridges running back from it to the end of the tooth (Busk).

[1] 'Trans. Zool. Soc.,' x, 1877, p. 60.

[2] 'Proc. Acad. Nat. Sci. Philad.,' 1894, p. 119.

5. The crown of $\overline{\text{m. 3}}$ is usually more angular behind than in *U. horribilis*. There is usually no sinus or constriction on the outer border. The grinding surface presents a few coarse folds, but is never tuberculated in the slightest degree (Busk).	The crown of $\overline{\text{m. 3}}$ is usually less angular behind than in *U. arctos*. In teeth of the typical triangular form there is no sulcus on the outer border. When the tooth is more elongated it presents a shallow sinus dividing the outer border. The grinding surface is coarsely ridged, rarely tuberculated (Busk).
6. The jugal arcade is more circular (Busk and Adams).	The jugal arcade is more elliptical (Busk and Adams).
7. The posterior narial openings are wide (Busk and Adams).	The posterior narial openings are of medium width (Busk and Adams).
8. The angular crotchet is less thick and incurved than in *U. horribilis* (Busk). The coronoid process is rather less broad and high (Owen).	The angular crotchet is thicker and more incurved than in *U. arctos* (Busk). The coronoid process is rather broader and higher (Owen).
9. The claws are less long and straight (Merriam).	The claws are longer and straighter (Merriam).

The constancy and importance of the above supposed distinctions may now be considered.

(1) The differences to which Busk refers are very slight, and so far as my own observation goes, quite inconstant and unreliable.

(2) The skulls of *U. horribilis* in the Zoological Department of the British Museum do not show any marked projection of the cingulum at the antero-internal corner of $\underline{\text{pm. 4}}$, or that the tooth tends to be shorter than in *U. arctos*.

(3) Busk considered that the relative length of the interspace between $\underline{\text{c.}}$ and $\underline{\text{pm. 4}}$, on which Owen laid stress, was not constant. This is also shown by the measurements in the table on p. 11.

(4) Nearly all palæontologists have laid stress on the structure of $\overline{\text{pm. 4}}$, this being specially the case with Busk. Lydekker considered that Busk attached undue importance to the structure of the talon. Brown, too, remarks that two skulls of *U. horribilis* in the British Museum do not possess the longitudinal ridges considered by Busk to be characteristic of $\overline{\text{pm. 4}}$ in this animal, while on the other hand a skull of the Isabelline bear, a variety of *U. arctos*, possesses them.

(6) The elliptical character of the jugal arcade is variable. In the case of two grizzly bear skulls in the College of Surgeons' Museum, in No. 856, the jugal arcade is more elliptical than in the brown bear skull No. 836, while in the grizzly bear skull No. 854 it is not more elliptical. The skull from Ballymahon in the British Museum, attributed by Adams to the grizzly bear, has the jugal arcade not more elliptical than the brown bear skull No. 218*e* in the British Museum.

(7) It is generally the fact that the posterior narial opening is wider in the

brown than in the grizzly bear, but this difference does not always hold, and skulls sometimes show a remarkable amount of variation in this respect.

Dr. H. Woodward[1] quotes Dupont as stating that skulls of brown and grizzly bears may be distinguished by the fact that *U. arctos* has only the last small upper premolar (*i. e.* $\underline{\text{pm. 3}}$), while the grizzly has also $\underline{\text{pm. 1}}$. Whether this were a true distinction could only be determined by reference to recent skulls, and in these it emphatically does not hold. The following table shows the distribution of the small premolar teeth in a number of bears' skulls, recent and fossil, and it will be seen that all the recent skulls of the brown bear referred to, show $\underline{\text{pm. 1}}$ in addition to $\underline{\text{pm. 3}}$; in one case also $\underline{\text{pm. 2}}$ is present.

(8) TABLE SHOWING DEVELOPMENT OF SMALL PREMOLARS AND OF CUSPS ON $\overline{\text{PM. 4}}$ IN BEARS OF THE *arctos* TYPE.

	$\underline{\text{pm. 1.}}$	$\underline{\text{pm. 2.}}$	$\underline{\text{pm. 3.}}$	$\overline{\text{pm. 1.}}$	$\overline{\text{pm. 2.}}$	$\overline{\text{pm. 3.}}$	Cusps on $\overline{\text{pm. 4.}}$
CRANIUM AND MANDIBLE.							
U. arctos, Kamtchatka, No. 91.12.18.13 (Brit. Mus.)	+	+	+	+	...	...	No cusps.
U. arctos, Jesso, No. 96.4.27.1 (Brit. Mus.)......	+	...	+	+	One side	...	1, 2, 3.
U. arctos var. *piscator*, N.W. Asia, No. 93.9.10.1 (Brit. Mus.)	+	...	+	+	...	...	2 (small).
U. arctos, No. 61.4.1.3 (Brit. Mus.)	Alv. one side	...	Alv.	Alv.	...	...	No cusps.
U. horribilis, No. 78.6.18.1 (Brit. Mus.)	+	...	+	...	...	...	2
U. horribilis, No. 58.6.18.10 (Brit. Mus.).........	+	...	One side	+	...	...	No cusps.
U. horribilis var. *horriæus*, No. 67.2.23.3 (Brit. Mus.)	+	...	+	+	+	+	No cusps.
U. horribilis, Muggendorf (Brit. Mus.)	+	...	+	+	...	...	No cusps.
U. horribilis,[1] Ballynamore (Brit. Mus.).........	Alv.	Alv.	Alv.	...	...	...	...
U. horribilis, Clonburne (Brit. Mus.)	Alv.	...	Alv.	...	...	...	...
U. horribilis, Ballymahon (Leeds, cast Brit. Mus.)	Alv.	...	Alv.	...	...	...	...
U. arctos,[1] Bourn, Lincoln (Mus. Pract. Geol.)	+	...	+	Alv.	...	...	...
U. arctos,[1] Burwell fen (Sedgwick Mus.).........	...	...	+	+ rt. side	...	Alv. rt. side	No cusps.
U. arctos,[1] Manea fen (Sedgwick Mus.)	Alv.	+	+	...	...	...	...
U. arctos[1] (labelled *U. spelæus*), Crayford, No. M.5041 (Brit. Mus.)	Alv.	Alv.	+	...	...	...	...
MANDIBLE.							
U. arctos, Manea fen (Fig. Owen, p. 106, fig. 35*a*), No. M.231 (Brit. Mus.)	...	...	...	Alv.	...	Alv.	1
U. arctos, St. David's (Brit. Mus.)	...	...	...	,,	...	...	No cusps.
U. arctos, Gower, No. 859 (Coll. Surgeons Mus.)	...	...	...	,,	...	...	2 (small).
U. horribilis, Grays, No. 22030 (Brit. Mus.) ...	...	...	...	,,	...	...	1, 3.
U. horribilis, Deborah Den, No. 40949 (Brit. Mus.)	...	...	...	,,	...	Alv.	Tooth wanting.

NOTE.—The position of the small cusps to which the figures 1, 2, 3 in the last column of the above table refer, is indicated in Fig. 6 on Pl. VI. In the other columns a + indicates that the tooth is present; if the tooth has been lost, but its socket is present, "Alv." is written.

[1] Figured.

[1] 'Geol. Mag.,' viii, 1871, p. 197.

Personally I am in agreement with the majority of zoologists referred to above, in being unable to find valid and constant characters enabling one to distinguish between the skeletal parts of the various bears of the *arctos* type. This conclusion has been stated by A. E. Brown[1] in the following forcible manner: "A critical survey of the cranial and dental characters shows little that is constant except variation, and absolutely forces the conclusion that there is not one [character] sufficiently stable and uniform to be of specific value. The European bear and grizzly run into one another so regularly that, except in extreme cases, there is no possibility of distinction apart from geographical considerations."

The differences separating the cave bear from the others are certainly greater than those between the different bears of the *arctos* type, but, unless perhaps in the case of $\overline{\text{pm. 4}}$, it is doubtful whether they are sufficiently marked and constant to afford specific distinctions. Certainly all the species of Pleistocene bears are closely allied and tend to run into one another, and it is perhaps not a matter of much practical importance whether they are grouped as one, two, or three species. On the whole it has seemed most satisfactory to recognise the specific distinction of *U. spelæus*, while grouping all the other Pleistocene bears as *U. arctos*.

V. BIBLIOGRAPHY.

1672. J. Paterson Hayn, 'Éphém. Curieux de la Nature,' dec. i, an. iii, obs. cxxxix, p. 220.

1673. H. Vollgnad, *ibid.*, an. iv, obs. clxx, p. 226.

1732. F. E. Brückmann, 'Bresl. Saml.,' p. 628, and 'Epist. Itin.,' p. 32.

1774. J. F. Esper, 'Ausführliche Nachricht—Zoolithen' (Bayreuth).

1784. J. F. Esper, 'Ecrits par la Soc. Nat. de Berlin,' v.

1794. J. Hunter, "Observations on Fossil Bones presented to the Royal Society," 'Phil. Trans.,' lxxxiv, p. 407.

1794. J. C. Rosenmüller, 'De Oss. Foss.,' p. 18 (Leipzig).

1794. J. C. Rosenmüller, 'Beitr. Gesch. Foss. Knochen,' p. 44 (Weimar, a German reprint of the above).

1803. J. F. Blumenbach, 'Spec. Archæologiæ Telluris,' iii, p. 12 (Göttingen).

1804. J. C. Rosenmüller, 'Abbild. u. Beschreib. der Foss. Knochen des Höhlenbären' (Weimar).

1806. G. Cuvier, "Sur les ossemens du genre de l'ours," 'Annales du Museum,' vii, p. 301.

1810. G. A. Goldfuss, 'Verhandl. k. Leopold-Karol. Acad. der Naturforscher,' x (2), p. 260.

1822. W. Buckland, "Account of an Assemblage of Fossils—Kirkdale Cave," 'Phil. Trans.,' cxii, p. 171.

[1] 'Proc. Acad. Nat. Sci. Philad.,' 1894, p. 119.

1823. W. Buckland, 'Reliquiæ Diluvianæ,' p. 35.
1823. W. Clift and J. Whidbey, "On some Fossil Bones—Oreston," 'Phil. Trans.,' cxiii, p. 88.
1825. G. Cuvier, 'Recherches sur les Ossemens fossiles,' ed. 3, iv, p. 340.
1828. J. B. Croizet and A. C. G. Jobert, 'Recherches sur les Ossemens fossiles du Dépt. du Puy-de-Dôme,' p. 828.
1830. M. de Serres, "Recherches sur les Ossemens fossiles du midi de la France," 'Bull. Univ. des Sci. Nat.,' no. 19, xii, p. 161.
1833. P. C. Schmerling, 'Recherches sur les Ossemens fossiles—Cavernes de Liège.'
1842. R. Owen, "Report on British Fossil Mammalia," 'Rep. Brit. Assoc.,' p. 62.
1844. H. M. D. de Blainville, 'Ostéographie,' ii, K.
1846. R. Owen, 'A History of British Fossil Mammals and Birds,' pp. 77–108.
1849. R. Ball, 'Proc. Roy. Irish Acad.,' iv, p. 416.
1851. A. Massalongo, 'Osteologia degli Ossi Fossili del Veronese' (Verona).
1851. J. A. Wagner, "Charact. der in Höhlen um Muggendorf . . . Säugthierarten," 'Abhandl. k. bayr. Akad. Wiss.,' vi, I. abth., p. 193.
1851. A. T. v. Middendorff, "Untersuchungen über Schädeln des gemeinen Landbären als krit. Beleuchtung der Streitfrage u. d. Arten fossiler Höhlenbären," 'Verhandl. Mineral. Gesell. St. Petersburg.'
1860. A. Carte, "Description of Fossil Bones discovered . . . at Shandon," 'Journ. Roy. Dublin Soc.,' ii, p. 352.
1860. H. Falconer, "On the Ossiferous Caves . . . of Gower," 'Quart. Journ. Geol. Soc.,' xvi, p. 487.
1862. W. Boyd Dawkins, "On a Hyæna Den at Wookey Hole, near Wells," *ibid.*, xviii, p. 115.
1864. A. Carte, "On the Former Existence of the Polar Bear in Ireland," 'Journ. Geol. Soc. Dublin,' x, p. 114.
1864. H. Denny, 'Proc. Yorks. Geol. and Polyt. Soc.,' iv, p. 338.
1864. J. E. Gray, 'Catal. Carniv. Pachyderm. and Edentate Mamm. in Brit. Mus.,' p. 217.
1867. G. Busk, "On Certain Points in the Dentition of Fossil Bears, and on the Relation of *U. priscus* to *U. ferox*" (abstract), 'Quart. Journ. Geol. Soc.,' xxiii, p. 342.
1869. J. A. Allen, "Catal. of Mammals of Massachusetts," 'Bull. Mus. Comp. Zool.,' i, p. 184.
1871. H. Woodward, "Visit to Royal Museum of Natural History, Brussels," 'Geol. Mag.,' viii, p. 197.
1872. A. Müller, 'Drei in der Provinz Preussen ausgegrabene Bärenschädel' (Königsberg).
1873. G. Busk, "Report on the Exploration of Brixham Cave—Animal Remains," 'Phil. Trans.,' clxiii, p. 499.

1875. W. Boyd Dawkins, "On the Mammalia found at Windy Knoll," 'Quart. Journ. Geol. Soc.,' xxxi, p. 250.

1876. W. Boyd Dawkins, "On the Mammalia and Traces of Man found in the Robin Hood Cave," *ibid.*, xxxii, p. 248.

1876. R. Hensel, "Ueber die Unterschiede zwischen *Ursus spelæus* u. *U. arctos*," 'Sitzb. Naturf. Freunde, Berlin,' p. 48.

1876. J. A. Allen, "Geographical Variation among North American Mammals," 'Bull. U.S. Geol. Surv. of Territ.,' ii, 4, p. 334.

1877. W. Boyd Dawkins, "On the Mammal-Fauna of the Caves of Cresswell Crags," 'Quart. Journ. Geol. Soc.,' xxxiii, p. 598.

1877. G. Busk, "On the Ancient or Quaternary Fauna of Gibraltar," 'Trans. Zool. Soc.,' x (2), p. 60.

1877. R. Johnson, "An Approximate List of the Extinct Mammalia of Norfolk," 'Trans. Norf. Nat. Soc.,' ii, p. 290.

1877. A. L. Adams, "Observations on Remains of Mammals found in a Fossil State in Ireland," 'Journ. Roy. Geol. Soc. Ireland,' iv, p. 246.

1878. A. L. Adams, "Report on History of Irish Fossil Mammals," 'Proc. Roy. Irish Acad.,' 2nd ser., iii, p. 94.

1879. A. L. Adams, "Report on the Exploration of the Shandon Cave," 'Trans. Roy. Irish Acad.,' xxvi (Sci.).

1880. A. L. Adams, "On Recent and Extinct Irish Mammals," 'Sci. Proc. Roy. Dublin Soc.,' ii, p. 49.

1880. E. T. Newton, "Notes on Vertebrata of Pre-glacial Forest Bed of E. of England," 'Geol. Mag.,' dec. ii, vol. vii, p. 153.

1881. A. L. Adams, "Report on Animal Remains of Bone Cave of Ballynamintra, co. Waterford," 'Trans. Roy. Dublin Soc.' (2) i, p. 201.

1882. E. T. Newton, "Vertebrata of Forest Bed Series of Norfolk," 'Mem. Geol. Surv.,' p. 5.

1884. R. Lydekker, "Post-tertiary and Tertiary Vertebrata, Siwalik and Narbada Carnivora," 'Palæont. Indica,' ser. 10, vol. ii, p. 202.

1885. R. Lydekker, 'Catal. of Fossil Mammalia in the British Museum,' pt. i, p. 173.

1887. A. Gaudry, "Le petit *Ursus spelæus* de Gargas," 'Comptes Rendus,' civ, p. 740.

1889. E. Schäff, "Ueber den Schädel von *Ursus arctos*," 'Arch. f. Naturgeschichte, p. 244.

1890. A. Smith Woodward and C. Davies Sherborn, 'A Catalogue of British Fossil Vertebrata,' p. 388 (London).

1892. A. Gaudry and M. Boule, 'Matériaux pour l'histoire des temps quaternaires,' fasc. iv, p. 105.

1893. A. Smith Woodward, "The Har Dalam Cavern, Malta. . . . Report on the Organic Remains," 'Proc. Roy. Soc.,' vol. liv, p. 278.

1894. A. E. Brown, "On the True Characters and Relationships of *Ursus cinnamomeus*," 'Proc. Acad. Nat. Sci. Philad.,' xlvi, p. 119.

1896. C. H. Merriam, "Preliminary Synopsis of the American Bears," 'Proc. Biol. Soc. Washington,' x, p. 65.

1897. R. Lydekker, "The Blue Bear of Thibet, with Notes on the Members of the *Ursus arctus* Group," 'Proc. Zool. Soc.,' p. 412.

1903. R. F. Scharff, "Exploration of the Caves of Kesh, co. Sligo (Mammals except Man)," 'Trans. Roy. Irish Acad.,' xxxii, B, pt. 4, p. 201.

1906. R. F. Scharff, "Exploration of the Caves of co. Clare (Animal Remains except Birds)," *ibid.*, xxxiii, B, pt. 1, p. 43.

PLATE I.

PLEISTOCENE BEARS (*U. spelæus*).

Cranium and Mandible.

FIG.

1. Lateral view of a skull from Banwell (one quarter natural size).
2. Dorsal } view of a cranium from Sandford (one third natural size).
3. Lateral }

Both specimens are in the Taunton Museum.

a. Mastoid process of periotic.

b. Post-orbital process of frontal.

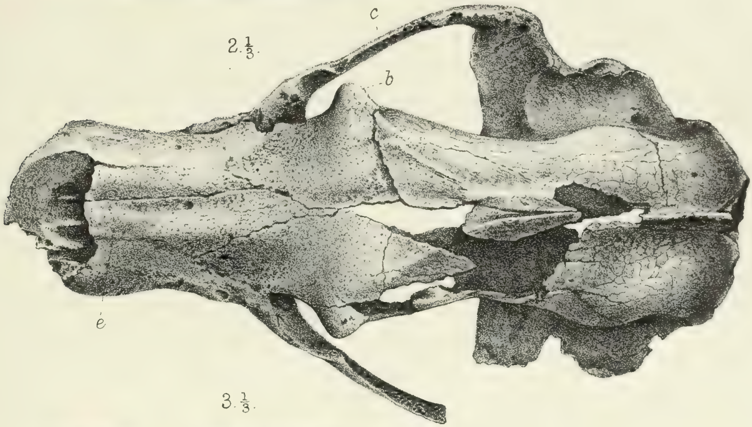
c. Jugal.

d. External auditory meatus.

e. Nasal.

1. $\frac{1}{4}$

2. $\frac{1}{3}$.



3. $\frac{1}{3}$.

J. Green del. lith et imp.

URSUS SPELÆUS.
Cranium & mandible.

PLATE II.

Pleistocene Bears.

Cranium and Mandible.

(The cranium one third, the mandibles one half natural size.)

Fig.

1. Posterior view of cranium of *U. spelæus* from Banwell.
2. Palatal view of mandible from Banwell.
3. Left mandibular ramus from Sandford, seen from the outer side.

All these specimens are preserved in the Taunton Museum. The mandibles are attributed to *U. spelæus.*

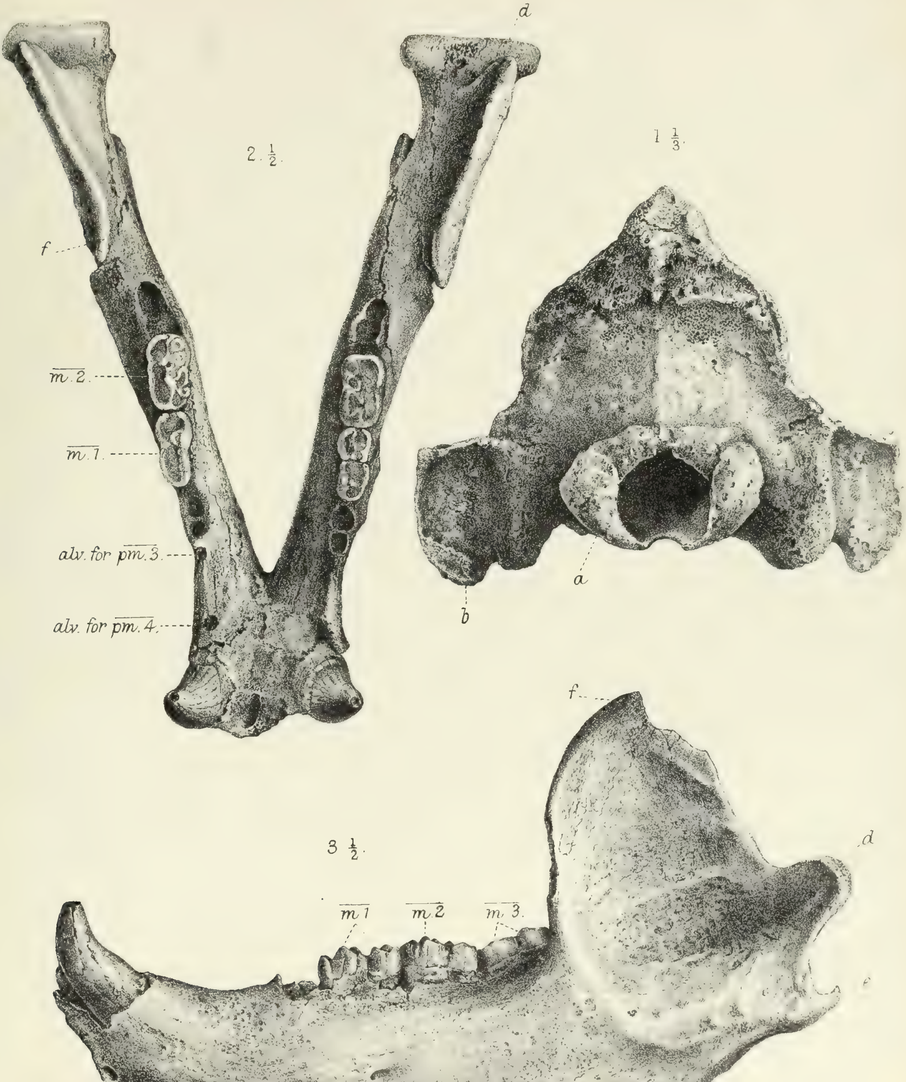
a. Occipital condyle.

b. Mastoid process of periotic.

d. Condyle of mandible.

e. Angle of mandible.

f. Coronoid process.



J. Green del.

URSUS SPELÆUS.
Cranium & mandible.

PLATE III.

PLEISTOCENE BEARS (*U. arctos*).

Cranium.

(One third natural size.)

FIG.

1. Dorsal view.
2. Lateral view.
3. Ventral view.

a. Post-orbital process of frontal.

b. Occipital condyle.

c. Post-orbital process of jugal.

d. Mastoid process of periotic.

e. Anterior palatine foramen.

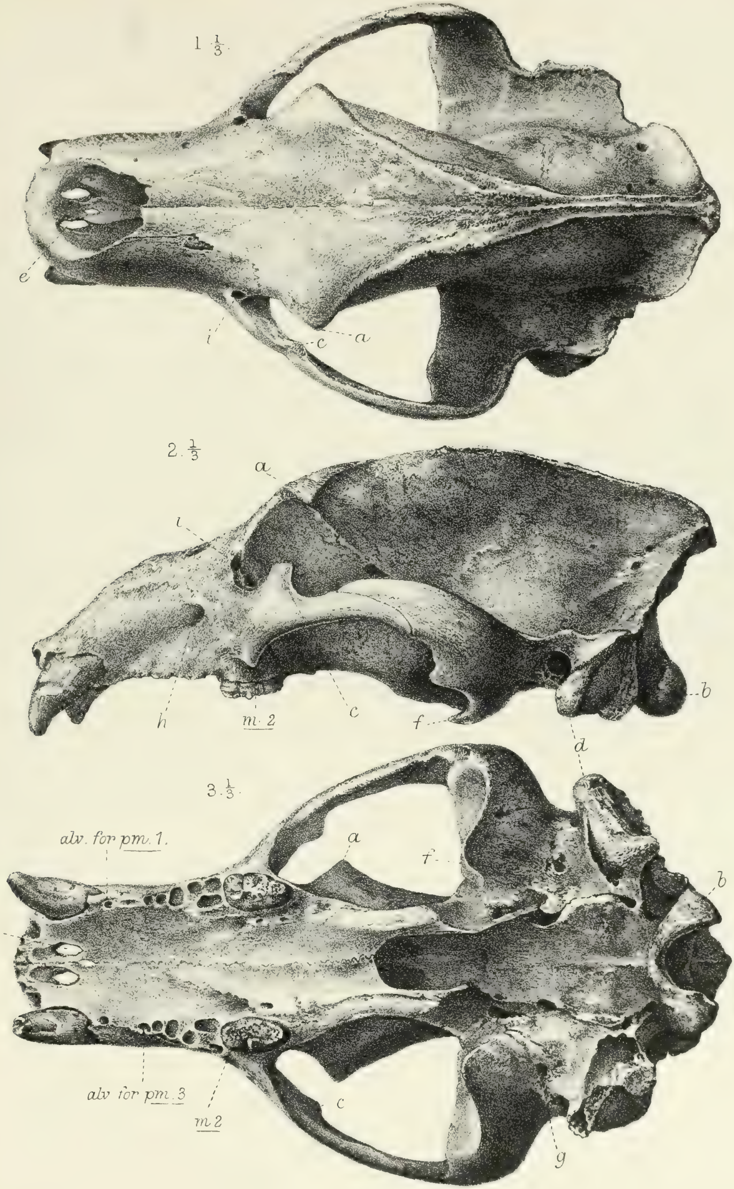
f. Post-glenoid process of squamosal.

g. Post-glenoid foramen.

h. Infra-orbital foramen.

i. Lachrymal foramen.

This specimen, which is preserved in the British Museum (Nat. Hist.), was found near Ballinamore, co. Leitrim. It is referred to as *U. ferox fossilis* by Busk, 'Phil. Trans.,' clxiii, p. 543 (1873), and Leith Adams, 'Trans. Roy. Irish Acad.,' xxvi, p. 225 (1879).



J. Green del. lith. et imp.

URSUS ARCTOS.
Cranium

PLATE IV.

Pleistocene Bears (*U. arctos*).

Cranium and Mandible.

(Two fifths natural size.)

Fig.

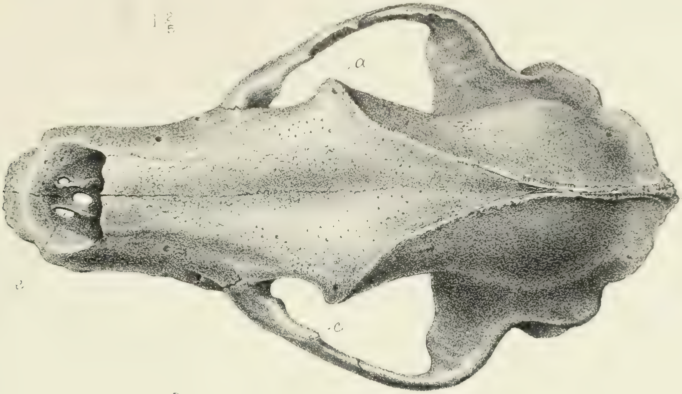
1. Dorsal view of the cranium.
2. The skull seen from the left side.
3. Ventral view of the cranium.

This specimen was found in the peat of Burwell fen, and is preserved in the Sedgwick Museum, Cambridge.

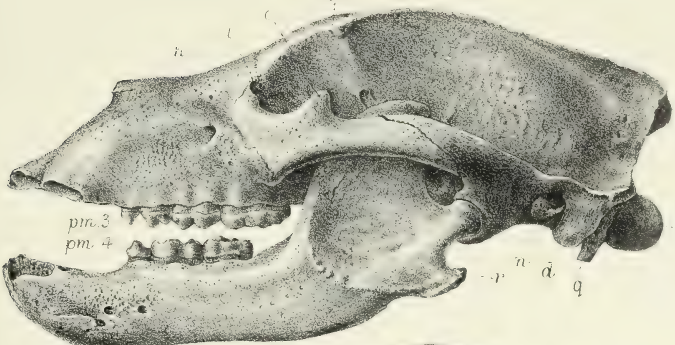
Lettering as in Plate III, with the addition of—

j. Condyloid foramen.
k. End of sagittal crest.
l. Foramen lacerum posterius.
m. Carotid foramen.
n. External auditory meatus.
o. Eustachian canal.
p. Posterior aperture of alisphenoid canal.
q. Paroccipital process of exoccipital.
r. Angle of mandible.

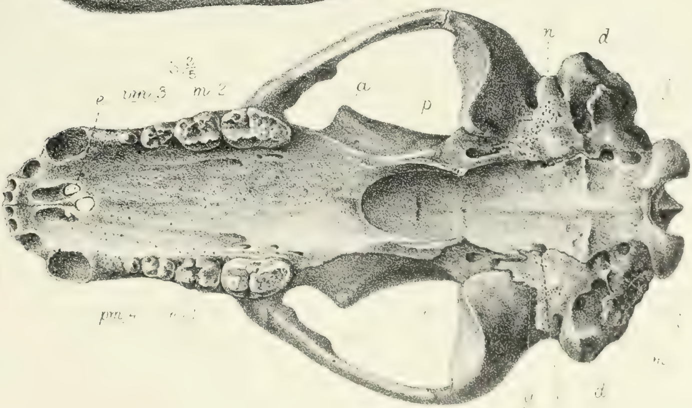
1 $\frac{2}{5}$



2 $\frac{2}{5}$



3 $\frac{2}{5}$



URSUS ARCTOS
Cranium & mandible

PLATE V.

Pleistocene Bears (*U. arctos*).

Mandible and Portions of Cranium.

(Fig. 3 one half, the others two thirds natural size.) Each figure shows the palatal aspect.

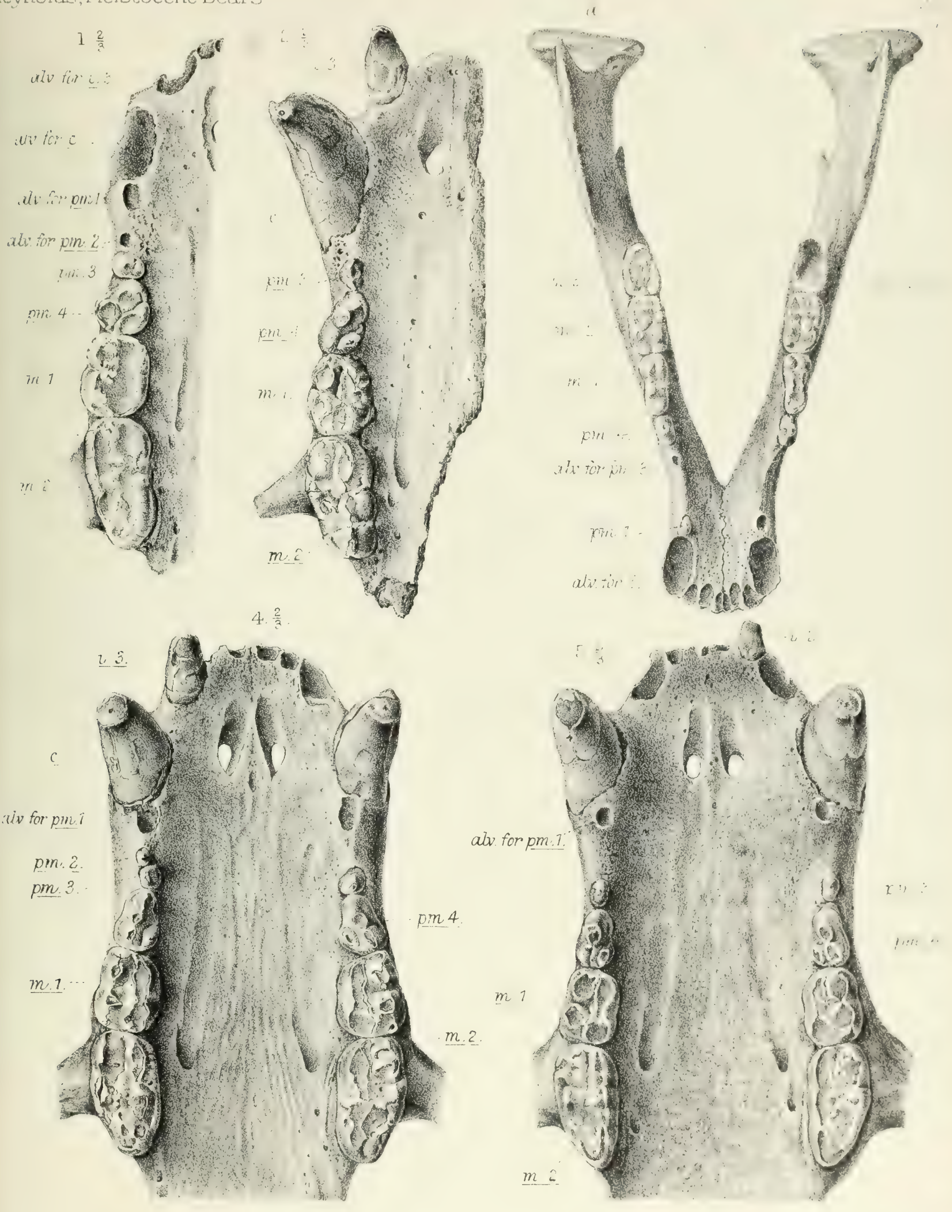
Fig.

1. Part of cranium from Crayford (No. M. 5041). Only the teeth of the right side and the neighbouring portion of the palate are figured. In the British Museum this specimen is labelled *U. spelæus*, but as all the upper premolars are represented, it seems better to attribute it to *U. arctos*.
2. Part of the right maxilla and premaxilla from Manea Fen (No. 40405).
3. Mandible from Burwell Fen.
4. Anterior part of cranium from Manea Fen.
5. Anterior part of cranium from Bourn, Lincolnshire.

The Manea Fen cranium (fig. 4) and the Burwell Fen mandible (fig. 3) are preserved in the Sedgwick Museum, Cambridge. The Bourn cranium (fig. 5) is in the Museum of Practical Geology, Jermyn Street. The other specimens are in the British Museum (Nat. Hist.), South Kensington.

a. Mandibular condyle.

b. Coronoid process.



URSUS ARCTOS.
Mandible & portions of crania.

PLATE VI.

Pleistocene Bears.

Permanent Dentition.

(Natural size.)

Fig.

1. Left upper teeth seen from the inner side
2. Left lower teeth seen from the inner side
3. Left upper teeth seen from the outer side
4. Left lower teeth seen from the outer side

} *U. arctos*, Torbryan Caves, Torquay (Mus. of Pract. Geol., Jermyn St.).

5. Grinding surface of left $\overline{\text{m. 3}}$ of *U. spelæus*, Kent's Cavern, Torquay (Brit. Mus.).

5 *a*. Grinding surface of left $\overline{\text{m. 3}}$ of *U. arctos*, Torbryan, Torquay (Brit. Mus.).

6 *a*. Left $\overline{\text{pm. 4}}$. *U. spelæus*, mandible No. M. 5995, Cromer Forest Bed (Brit. Mus.).

6 *b*. Left $\overline{\text{pm. 4}}$ *U. ferox* (*horribilis*), mandible No. 22029, Grays, Essex (Brit. Mus.).

6 *c*. Right $\overline{\text{pm. 4}}$ *U. spelæus*, mandible from Bacton (Brit. Mus.).

6 *d*. Right $\overline{\text{pm. 4}}$ *U. arctos*, a recent skull, No. 96.4.27.1, from Jesso, Japan (Brit. Mus.). All the teeth in fig. 6 are seen from the inner side.

a. Anterior cone.

b. Posterior cone.

c. Inner cusp or lobe.

d. Anterior external cusp.

e. Outer tubercle.

In fig. 6, 1 = anterior
2 = middle
3 = posterior

} of the small cusps referred to in the last column of the table on p. 31.

URSUS.
Dentition.

PLATE VII.

Pleistocene Bears.

Vertebræ.

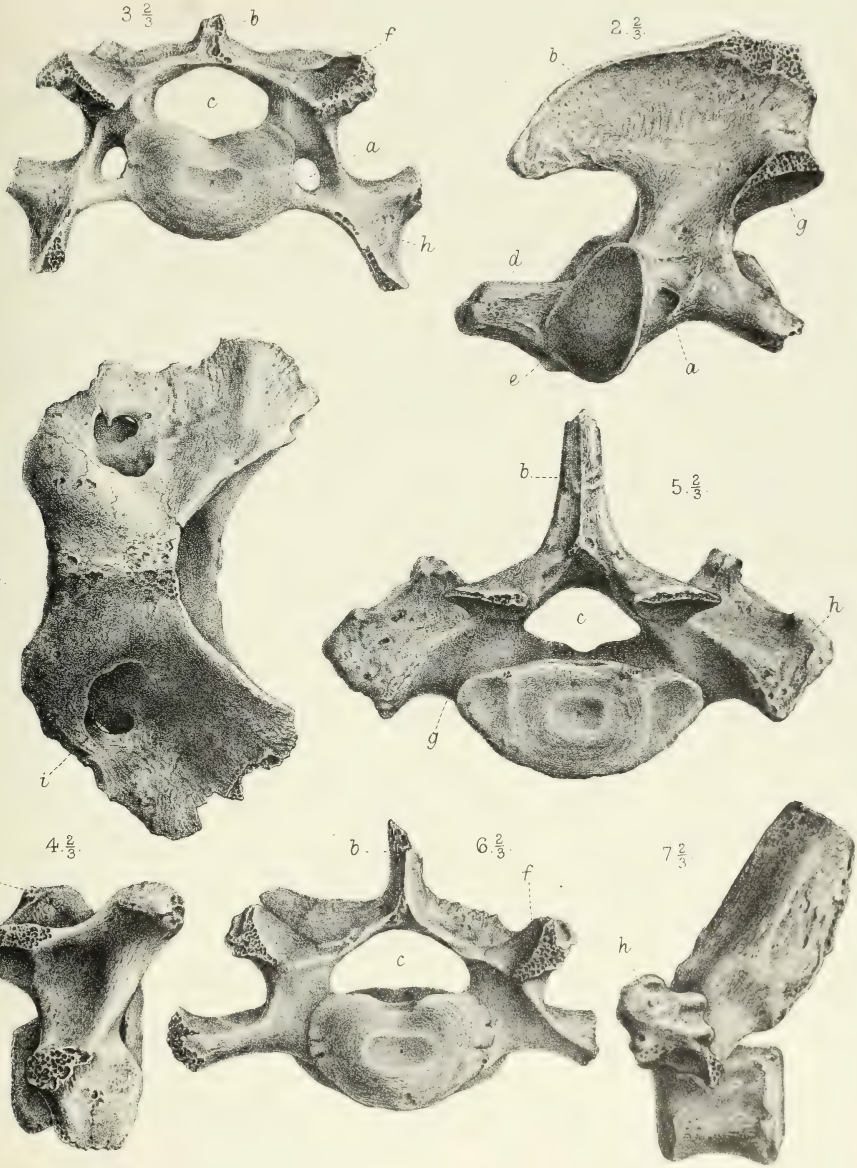
(Two thirds natural size.)

Fig.

1. Atlas, dorsal aspect.
2. Axis, seen from left side.
3. Fourth cervical, front view.
4. Fourth cervical, seen from the right side.
5. Seventh cervical, back view.
6. First thoracic, front view.
7. Second thoracic, seen from the left side.

All the above specimens are from Sandford Hill, Somerset, and are preserved in the Taunton Museum.

a. Vertebrarterial canal.
b. Neural spine.
c. Neural canal.
d. Odontoid process.
e. Anterior articulating surface for atlas.
f. Pre-zygapophysis.
g. Post-zygapophysis.
h. Transverse process.
i. Foramen for exit of spinal nerve.



URSUS.
Vertebræ.

PLATE VIII.

Pleistocene Bears.

(*Vertebræ.*)

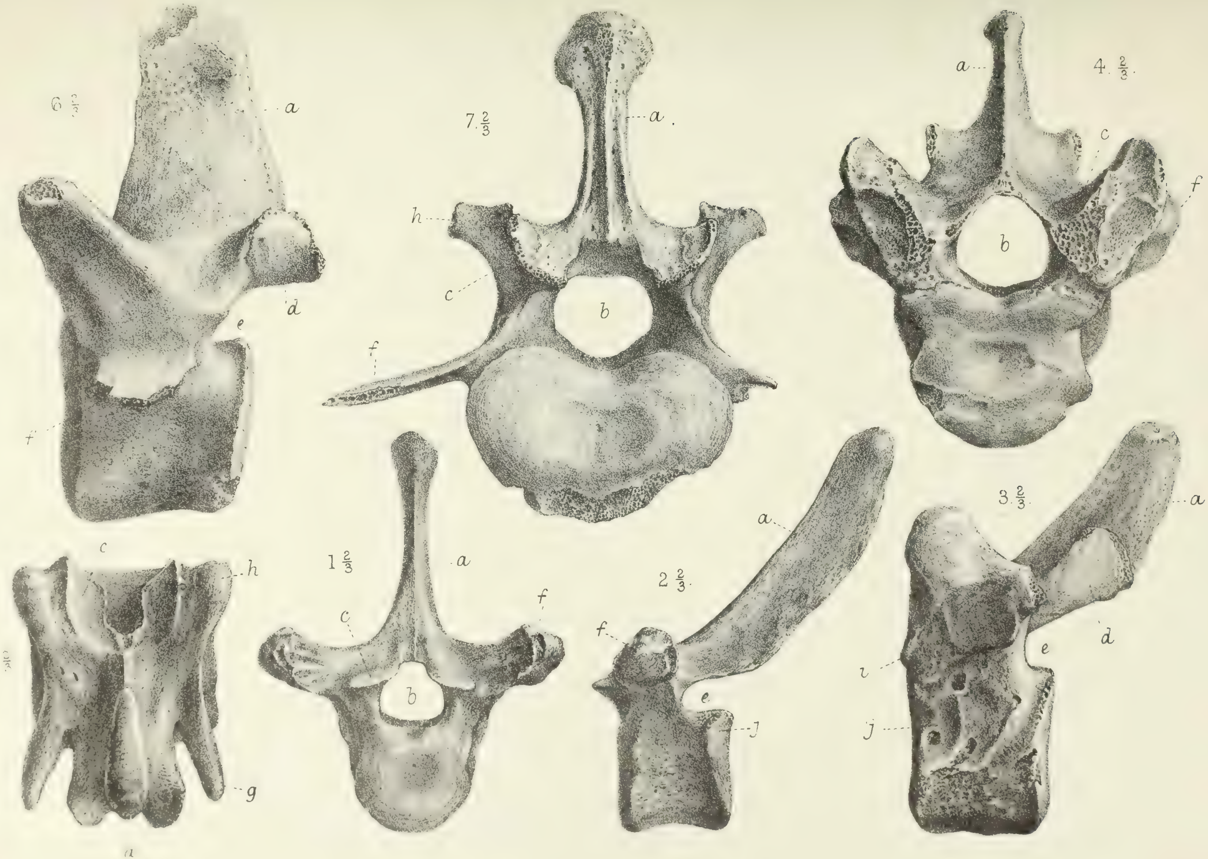
(Two thirds natural size.)

Fig.

1. Third thoracic, front view.
2. Fifth thoracic, left side view.
3. Twelfth thoracic, left side view.
4. Twelfth thoracic, front view.
5. Fourteenth thoracic, dorsal view.
6. Third lumbar, left side view.
7. Third lumbar, front view.

Figs. 1, 2, and 5 are drawn from vertebræ found in the peat at Burwell Fen, and now preserved in the Sedgwick Museum, Cambridge; the others are from Sandford Hill, and are preserved in the Taunton Museum.

a. Neural spine.
b. Neural canal.
c. Pre-zygapophysis.
d. Post-zygapophysis.
e. Notch for exit of spinal nerve.
f. Transverse process.
g. Anapophysis.
h. Metapophysis.
i. Facet for articulation with tubercle of rib.
j. Facet for articulation with head of rib.



J. Green del lith et imp

URSUS.
Vertebræ.

Palæontographical Society, 1906.

A MONOGRAPH

OF

THE FISHES

OF THE

OLD RED SANDSTONE OF BRITAIN.

BY

RAMSAY H. TRAQUAIR, M.D., LL.D., F.R.S.,

LATE KEEPER OF THE NATURAL HISTORY COLLECTIONS IN THE ROYAL SCOTTISH MUSEUM, EDINBURGH.

Part II, No. 3.—THE ASTEROLEPIDÆ.

Pages 119—130; Plates XXVII—XXXI.

LONDON:

PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.

1906.

PRINTED BY ADLARD AND SON, LONDON AND DORKING.

the 'Poiss. Foss. v. Grès rouge' after a drawing communicated to him by Dr. Malcolmson. The original specimen is stated by Agassiz to be in the Elgin Museum, but Dr. Smith Woodward states that it is in the collection of the Geological Society of London. Two other fragments of the pectoral appendage from the same locality, and now in the Edinburgh Museum, were also described and figured by Agassiz as belonging to a distinct genus, namely "*Placothorax*," while the impressions of three plates from Alves, in the British Museum collection, were referred in the same work to the Russian *Bothriolepis ornata*, Eichwald. The bases of the tubercles are in *B. major*, as we have seen, frequently stellate, a feature wanting in *B. ornata*, so far as is known; and if Eichwald's figure of the entire anterior median dorsal plate in his species is correct, that element in *B. major* strongly differs from it in its much greater proportional breadth.

Another closely allied Russian form is the *B. Panderi* of Lahusen, of which there are some fragments, from the Sjass River, in the Edinburgh Museum. From these it would appear that, in many places, the tubercles, which are very frequently stellate, tend to be not quite so confluent as in *B. major*, and that the angulated flexure of the sensory groove on the premedian plate is more acute; but more cannot be said at present.

As regards the external sculpture of *B. major*, it is to be noted that, as already indicated in the text and borne out by our figures, there are great differences in the relative fineness and coarseness of the markings. As a rule this depends on the age and size of the individual, the smallest specimens having the finest sculpture and *vice versâ*, but instances also occur (see Pl. XXIII, figs. 5 and 6), in which plates of much the same size differ markedly from each other in this respect. The same remarks apply more or less to other species of Asterolepidæ.

Geological Position and Localities.—Characteristic of the middle division of the Upper Old Red Sandstone of the Moray Firth area, the remains of *Bothriolepis major* are found in all the localities for fish-remains in that series, as—

Banks of the Findhorn River;

Old quarries at Whitemire, near Brodie Station;

Carden Hill, Sweet Hillock, Rocky Park, Millstone Quarry, and Newton Quarry, near Alves;

Redhall Quarry, near Fochabers;

Scat Craig;

also in the uppermost or "Rosebrae" beds of the same formation at Rosebrae and Laverock Loch, near Elgin.

BOTHRIOLEPIS OBESA, *Traquair*. Plates XXVII and XXVIII.

1888. BOTHRIOLEPIS OBESA, *Traquair*. Geol. Mag. (3), vol. v, p. 510.
1891. — — *A. S. Woodward*. Cat. Foss. Fishes Brit. Mus., pt. ii, p. 228.
1893. — — *Traquair*. Proc. Roy. Phys. Soc. Edin., vol. xi, p. 285.

Specific Characters.—Anterior median dorsal plate *carinated*; the other plates indicate a peculiarly short, thick-set form of carapace; tuberculation similar to that of *B. major.*

Description.—All the figures illustrating this species on Pl. XXVII and XXVIII are three quarters natural size.

The specimens used as types by me in my original brief description ('Geol. Mag.,' 1888) are from the neighbourhood of Jedburgh and must therefore be noticed first.

In Pl. XXVIII, Fig. 1, is shown a specimen of the right anterior ventro-lateral plate, cut off behind by the edge of the stone, but showing the regularly convex outline of the anterior margin in its entirety. The position of the large articular fossa for the pectoral appendage is seen as well as the remains of the brachial, or "helmet" process itself. More than one half of the bony substance of the plate has flaked off, showing the smooth internal cast below; what remains is, however, of considerable thickness, and is ornamented by a confluent tuberculation similar to that which occurs on most plates of *B. major.*

In Fig. 2 we have a specimen of the left *anterior ventro-lateral* plate, unfortunately deficient at the anterior and external part in front of the articular fossa; otherwise the contour of the plate is complete. The first thing which strikes the eye is the large size of the articular fossa and its relatively posterior position on the outer side of the plate; and the next is that the posterior margin of the ventral or horizontal portion of the plate passes obliquely across in a slightly convex line. Along the inner margin we see very distinctly the narrow area overlapped by the corresponding plate of the other side.

Fig. 3 shows the horizontal part of the left *posterior ventro-lateral* plate, deficient, however, posteriorly, as the hinder extremity is cut off by the edge of the stone. Here the anterior margin is seen to pass straight across, cutting the inner one at a right angle, which seems to show no truncation for a median ventral. Was the last named plate absent in this case? I think not; my explanation of the appearance being that the anterior margin of the plate is deficient.

The same specimen placed horizontally and seen from the outer side is shown in Fig. 4. Here we have a view of the ascending lamina of this posterior ventro-lateral plate, which is seen to be proportionately higher than in *B. major*. The external ornament is here almost completely gone.

In Fig. 5 we have a view of the right *posterior dorso-lateral* plate from which, unfortunately, the greater part of the outer surface has been lost, so that only the faintest traces of external sculpture are seen. Its high and broad contour may be noted, as well as the narrow area in front, where it is overlapped by the anterior dorso-lateral, above which, and along the anterior part of the upper margin, is an internal impression of the arm, which overlaps the anterior median dorsal.

In Pl. XXVII, Fig. 1, is represented a specimen of the *anterior median dorsal* plate. It is, unfortunately, a "bad" specimen, as it wants the posterior extremity and is also considerably broken away along the sides, besides which most of the bony material of the plate is gone. The outlines of the areæ on each side overlapping the anterior dorso-lateral plates clearly indicate the genus *Bothriolepis*, while the elevated form of the plate, distinctly carinate posteriorly, is in marked distinction to the condition in *B. major*.

The internal surface of this plate (*anterior median dorsal*) is shown in Fig. 2, Pl. XXVII, taken from a plaster mould. Comparing this with the corresponding view of the same plate in *B. major* (Pl. XXIV, Fig. 2), we find a general agreement as to outline and markings, with a very decided difference in this respect, that while in the latter the surface is much flattened, in the present plate it is deeply hollowed longitudinally, the hollow indicating, of course, a corresponding longitudinal elevation or carina, of the middle of the outer surface.

Turning now to the remaining specimens, which are from Harelaw, near Chirnside, in Berwickshire, we find that they exist only as impressions on the stone, a coarse, deep brick-red sandstone, and consequently the figures here given of them are taken from plaster moulds, as in the case of most of the plates of *B. major* from Alves. Fig. 3, Pl. XXVII, represents a broken *anterior median dorsal* plate showing marked carination behind the central point, and a sculpture resembling that of *B. major*. Posteriorly, part of the area overlapped by the posterior median dorsal is observable. In Fig. 4 we have a left *posterior dorso-lateral* plate, which, however, unfortunately wants a considerable portion above and in front. The longitudinal carina dividing the dorsal from the lateral surface is here prominently developed, the lateral sensory groove being seen a little way under it. All the articular areæ of the outer surface of this plate in *Bothriolepis* are seen—namely, one above and behind, overlapped by the posterior median dorsal, an extensive one below overlapped by the ascending lamina of the posterior ventro-lateral, and another in front overlapped by the anterior dorso-lateral.

Fig. 5 represents a portion of the plates of the upper arm, seen from the inside,

and having the outer margin placed upwards. It is to be noted that this outer margin displays a row of stout denticles like those in *B. canadensis*, etc.

In Fig. 6 we have a plaster mould of a fragment of a head, showing a large portion of the *median occipital*, and nearly the whole of the *post-median* plate. The former plate seems to differ from the corresponding one in *B. major*, by having the posteriorly directed apex of the V-shaped sensory groove somewhat farther forward.

Remarks.—In looking back on the rather fragmentary material which I have brought together under the term *Bothriolepis obesa*, it is difficult to clear one's mind altogether of a doubt as to whether more than one species may not be here included. In other words, might not possibly the Harelaw specimens (Pl. XXVII, Figs. 3—6) be different in that respect from the others which are from the neighbourhood of Jedburgh? It is, however, difficult to formulate unmistakable evidence of such a view, so I consider it better to keep the specimens together under one name until further material is forthcoming. Meanwhile, taking everything into account, we have here a form distinguished from *B. major* by the obvious carination of the anterior median dorsal plate (the posterior one is not yet in evidence), the short and deep aspect of the lateral plates, and, if the samples from Harelaw belong to the same species, also by the prominent serration of the outer aspect of the external marginal plate of the pectoral appendage. Further material is much to be desired, as I have seen no specimens save the few which are preserved in the Natural History Department of the Royal Scottish Museum, and in the Collection of the Geological Survey of Scotland. These were, I understand, all obtained from quarries which have not been worked for many years.

Geological Position and Localities.—The specimens represented on Pl. XXVIII, Figs. 2—4, and on Pl. XXVII, Fig. 2, are from Rule Water, Jedburgh, Roxburghshire; those seen in Pl. XXVII, Fig. 1, and in Pl. XXVIII, Figs. 1 and 5, are also from the neighbourhood of that town, though the precise locality is not known, while Figs. 3, 4, 5, and 6 on Pl. XXVII are taken from plaster moulds of specimens from Harelaw, near Chirnside, in Berwickshire.

BOTHRIOLEPIS LEPTOCHEIRUS, *Traquair*. Plate XXIX.

1869. PTERICHTHYS MAJOR, *A. Geikie*. Expl. of Sheet 14, Geol. Survey of Scotland, pp. 12 and 13.
1882. — — *A. Geikie*. Text-book of Geology, p. 716.
1888. BOTHRIOLEPIS MAJOR, *R. H. Traquair*. Ann. and Mag. Nat. Hist. (6), vol. ii, p. 501.
1892. — LEPTOCHEIRUS, *R. H. Traquair*. Proc. Roy. Phys. Soc. Edin., vol. xi, p. 286.

Specific Characters.—Plates of carapace *thin*, sculpture as in *B. major*, but relatively rather finer; median dorsal plates not keeled; pectoral appendages long and *slender*; no prominent denticulations observable on their outer margins.

Description.—The remains of this species occur, like those of the larger species of *Bothriolepis* generally, in a dislocated condition, the only elements found in apposition being those of the upper arm, which may also still remain in conjunction with the anterior ventro-lateral plate. Such a specimen is seen, natural size, in Pl. XXIX, Fig. 3, which represents the outer surface of an almost complete example of the right *anterior ventro-lateral* plate, with the proximal part of the pectoral limb attached. The bony matter of the plate is relatively thin, but the external sculpture is seen to present the same tuberculo-reticulate character which we have already seen in *B. major*, though relatively more delicate than is usually the case in the last named species. Attached to the articular fossa of this plate is the proximal segment of the arm, but split through the middle so as to show the internal surfaces of the plates forming its dorsal aspect. We are struck with the proportionally long and slender appearance of this upper arm, compared with the same part in other species, and this character is also shared by the distal portion represented in Fig. 5. Fig. 4 shows the isolated articular element of the arm, with an imperfect posterior median-dorsal plate on the same portion of stone. The former, seen from the external surface, is proportionately more slender than in *B. major* (see Pl. XXVI, Figs. 2 and 3), as its greatest breadth is contained three and a third times in its length, whereas in *B. major* the proportion is as one to three. In other examples of the upper arm of *B. leptocheirus* the proportion of the breadth to the length of this articular element is as one to three and a half. No specimen of the arm shows any prominent denticulation of the external marginal element, the species agreeing in this respect with *B. major*.

As to the peculiar proportional slenderness of the arm, on account of which I have given the name of *leptocheirus* to the present species, there can be no doubt, but at the same time I rather think that this slenderness is more due to proportional narrowness than to excessive length.

In Fig. 2 we have a portion of the outer aspect of the upper end of an arm, showing the junction of the two *articular* elements, dorsal and ventral, over the proximal end of the *external marginal.*

Fig. 1 shows the *premedian* plate of the top of the head with the sensory groove crossing it just behind the anterior margin. In form and in general aspect it scarcely differs from that in *B. major*.

Returning to Fig. 4, we have noticed that it displays, besides the already described articular plate, a considerable portion of a *posterior median dorsal.* This is seen with the posterior extremity and margin directed upwards; such of the bony matter as is present is viewed from the internal aspect, and where it has

flaked off the impression of the outer sculpture is seen on the stone. From this impression it is clear that there was no median carina.

Other plates found in a more or less fragmentary condition on the few slabs showing remains of this species in the Royal Scottish Museum, are the anterior median dorsal, which, like the posterior one, seems to have no median carina—the *anterior* and *posterior dorso-laterals*, and the *posterior ventro-lateral*—but want of space prevents me from giving figures of them. Their external sculpture agrees with that shown in the figures given in Pl. XXIX, while in contour they resemble the plates of *B. major*.

Remarks.—The plates of this species were referred by Sir A. Geikie in 1869 and in 1882 to "*Pterichthys*" *major*, and in 1888 I also considered them as belonging to the same species, which I placed, however, in *Bothriolepis*. Subsequent closer study convinced me of their specific distinction, and accordingly in 1892 I separated them under the name of *Bothriolepis leptocheirus*.

Geological Position and Locality.—From the Upper Old Red Sandstone at the Heads of Ayr, Ayrshire, in the collections of the Royal Scottish Museum and of the Geological Survey of Scotland. In the latter collection there are also an anterior dorso-lateral plate and some other fragments from the same formation at Siccar Point, Berwickshire, which are, in my opinion, also referable to this species.

BOTHRIOLEPIS HYDROPHILA, *Agassiz*, sp. Plate XXX, figs. 1—3.

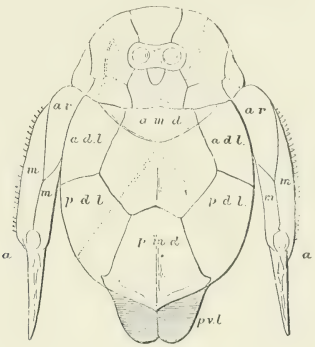
1844. PTERICHTHYS HYDROPHILUS, *Agassiz*. Poiss. Foss. v. Grès rouge, Atlas, pl. iv, figs. 4—6.
— PAMPHRACTUS — *Agassiz*. Ibid., text pp. 5 and 21.
— — ANDERSONI, *Agassiz*. Ibid., p. 21.
1845. HOMOTHORAX FLEMINGII, *Agassiz*. Ibid., p. 134, pl. xxxi, fig. 6.
1848. PTERICHTHYS HYDROPHILUS, *Egerton and Hugh Miller*. Quart. Journ. Geol. Soc., vol. iv, pp. 312, 314.
1859. PAMPHRACTUS ANDERSONI = PTERICHTHYS HYDROPHILUS, *J. Anderson*. Dura Den, pp. 49, 52, pl. i, fig. 1.
1862. PTERICHTHYS HYDROPHILUS, *J. Powrie*. Quart. Journ. Geol. Soc., vol. xviii, p. 435.
1888. BOTHRIOLEPIS HYDROPHILUS, *R. H. Traquair*. Geol. Mag. (3), vol. 5, p. 510, and Ann. and Mag. Nat. Hist. (6) vol. ii, p. 500, pl. xviii, figs. 4, 5.
1891. — HYDROPHILA, *A. S. Woodward*. Cat. Foss. Fishes Brit. Mus., pt. ii, p. 230.

Specific Characters.—Length of head contained three times in the total of the

dorsal aspect; breadth of dorsal part of body-carapace equal to its length; posterior median dorsal and posterior part of anterior median dorsal plates distinctly carinate; external surface of body-plates covered with a reticulate sculpture, which is in places slightly nodose; proximal part of pectoral appendage rather broad and relatively long, being nearly twice as long as the distal part, and having a row of specially strong denticles along its outer margin.

Description.—The head is shown in Pl. XXX, Fig. 2, in impression in Fig. 1, and in restored outline in the appended Text-figure 62, and shows this peculiarity, that in no specimen have I been able to discover any commissure of the lateral line system across the pre-median plate in front of the orbit. The plates filling the orbital space are, however, pretty well exhibited in Fig. 2.

FIG. 62.



Restored outline of the dorsal surface of *Bothriolepis, hydrophila,* from specimens in the Royal Scottish Museum. *a.*, anconeal; *a. m. d.*, anterior median dorsal; *a. d. l.*, anterior dorso-lateral; *ar.*, articular; *m.*, marginal; *p. d. l.*, posterior dorso-lateral; *p. m. d.*, posterior median dorsal; *p. r. l.*, posterior ventro-lateral.

The dorsal aspect of the carapace is also shown in Fig. 2, and we have a very good impression of it in the left-hand specimen on the slab depicted in Fig. 1. The *anterior median dorsal* plate is worthy of attention, as in most cases a right and left shallow-pointed depression, passing backwards and inwards from the antero-lateral angle, meets its fellow of the opposite side at an angle in the middle line about the junction of the anterior and middle thirds of the plate, the two depressions bounding between them a gently convex triangular portion, with backwardly directed apex. This is seen in Fig. 2, but more especially in the detached plate from Clashbennie represented in Fig. 3. Behind this the posterior third of the plate shows a distinct median carination, which is continued backwards on the posterior median dorsal. The other plates of the dorsal surface show

nothing special as regards their contour, nor do those of the ventral aspect, which is the one shown by the right-hand specimen in Fig. 1. It is, however, to be noted that this ventral part of the carapace is, in this individual, not preserved in the centre, and that this is the case in most of the specimens lying in a similar position which I have as yet seen.

The external surface of the plates of the head and body is covered with a sculpture, which has the original tuberculation mostly so confluent as to produce a pitted-reticulate appearance, which, though nodose in places, seems most appropriately to agree with the term "Bothriolepis." As shown in the restored outline, Text-fig. 62, the V-shaped sensory canal on the anterior median dorsal and posterior dorso-lateral plates is disposed quite as in *B. Canadensis* (Text-fig. 57, p. 112), but, as already mentioned, I have seen no trace of the usual transverse commissure of this system on the head in front of the orbit.

The pectoral appendages are not longer than is usual in the genus *Bothriolepis*, but the proximal segment, twice as long as the distal one, is broad and strongly denticulated along the outer margin.

Remarks.—If I am right in referring the plate represented in Pl. XXX, Fig. 3, to this species, then Dr. Fleming was the first to figure any relic appertaining to it. For this plate, now in the Royal Scottish Museum, is the one, from the Upper Old Red of Clashbennie in Perthshire, figured by that pioneer in Scottish palæontology in 1831,[1] of which he wrote that "in external appearance it bears a very close resemblance to some of the scales on the common sturgeon." That this detached plate is the anterior median dorsal of a *Bothriolepis* there is not the smallest doubt, and my idea that it belongs to *B. hydrophila* is founded, first, on the manner in which a triangular area, with backwardly directed apex, is marked off in front by two convergent shallow depressions, and, secondly, on the reticulate-pitted nature of the sculpture, which is, however, relatively coarser than in the Dura Den specimens. As regards the latter, among which, of course, are the types of the species, the first notice and figure were given by the Rev. Dr. Anderson in 1840 in a publication called 'Fife Illustrated,' vol. i, pp. 195, 196.[2] Here the creature is given a place among the Coleoptera or beetles, and is said specially to "resemble the family of Curculionidæ, of which the diamond beetle is an example of the existing race, but of the most insignificant dimensions as compared with the Dura fossils." He remarks, however, on the apparent absence of elytra and antennæ, and on the fact

[1] 'Edinburgh Journal of Natural and Geographical Science,' vol. iii, Feb., 1831, pp. 85, 86, pl. ii, fig. 3.

[2] 'Fife Illustrated,' or 'History of the County of Fife,' by J. Leighton and J. Swan, with steel engravings by J. Stewart, three vols. 4to, Glasgow, 1840. In Vol. I a chapter on the Geology is contributed by the Rev. Dr. Anderson, with one plate of fossils, fig. 6 of which represents the supposed "beetle."

that "the number of legs are limited to two in every one of the specimens in my possession, amounting to impressions of twenty animals." The following year (1841) saw the publication of Hugh Miller's 'Old Red Sandstone,'[1] in which classic work the talented author rather scoffed at Dr. Anderson's "beetle," and even went so far as strongly to hint that the figure was purposely made up so as to make the creature look more insect-like. But the good clergyman, however slender his acquaintance with zoology might be, was not guilty of wilful pictorial misrepresentation; his figure is not bad, and no present-day palæichthyologist could be in doubt as to the affinities of the animal it was meant to represent. In the same place Hugh Miller mentions that Agassiz had pronounced it to be a *Pterichthys*, an opinion with which he cordially agreed. And as "*Pterichthys hydrophilus*" the figures of the species given in Table IV of the "Atlas" to the 'Poissons Fossiles du vieux Grès rouge' (1844) are designated, though in the letterpress and in the case of the restored figure in Table IV the generic name *Pamphractus* is adopted, of which new genus the main distinctive characters were "le developpement excessif de la plaque centrale de la carapace, qui atteint l'articulation de la tete, l'absence d'un ceinture thoracique faisant le tour du corps; et la demarcation distincte de l'articulation occipitale" (text, p. 20). But, as shown in 1848 by Sir Philip Egerton and Hugh Miller, Agassiz, having all along mistaken the ventral for the dorsal surface of *Pterichthys*, might well find a difference between *that* and the *real dorsal* surface of the Dura Den fossil, which in his restored figure (*op. cit.*, pl. vi, fig. 2) is quite recognisable as dorsal in spite of errors of detail. For, of course, the so-called "plaque centrale," with its "developpement excessif," and attaining the articulation of the head, is the anterior median dorsal, and the occipital articulation only appears on the dorsal aspect of the fish. The genus *Pamphractus* was, therefore, abolished by Egerton and Miller, and the species *hydrophilus* restored to *Pterichthys*. More than this, Hugh Miller in the same paper also decided that the drawing received from Fleming, and on which Agassiz founded his "*Homothorax Flemingii*," represented "the under surface of the *Pamphractus* drawn from a rather imperfect specimen of *Pterichthys hydrophilus*, which did not indicate the divisions of the plates." There can be no doubt that this is a correct interpretation of the figure of this supposed additional genus from Dura Den given by Agassiz on pl. xxxi, fig. 6, of his 'Poissons Fossiles du vieux Grès rouge.'

That the Dura Den Asterolepid belonged to a genus different from *Pterichthys* was, nevertheless, perfectly true, though the reasons for separating it given by Agassiz did not hold. For when, in 1888, I looked into the question of the structure and classification of the Asterolepidæ I found that *Pterichthys hydrophilus*, Ag., and *Pt. macrocephalus*, Egerton, must certainly follow *Pt. major*, Ag., into

[1] 'The Old Red Sandstone,' ed. 1, 1841, pp. 173–174.

the genus *Bothriolepis* (*see* p. 110). The close affinity of *B. hydrophila* to *B. Canadensis* may be at once seen on comparing the restored figures which I have given of each (pp. 112 and 125).

Geological Position and Localities.—From the Scottish Upper Old Red Sandstone. Unless Fleming's isolated plate from Clashbennie (Pl. XXX, Fig. 3) belongs to the same species, the only known locality for *Bothriolepis hydrophila* is Dura Den, in Fifeshire, where, like the *Holoptychius Flemingii*, it has occurred in large numbers, closely packed together, one slab in the Royal Scottish Museum, measuring nineteen by eleven inches, containing no less than twenty examples, complete and incomplete. It would seem, however, that the *Bothriolepis* bed is not the same as that in which the remarkable shoal of *Holoptychii* lies entombed, but according to Dr. Anderson is "about fifty feet above the *Holoptychius* bed, which lies in the bottom of the ravine, and level with the rivulet which traverses it" ('Dura Den,' p. 52).

Bothriolepis macrocephala, *Egerton*, sp. Plate XXX, figs. 4, 5, 6.

1862.	Pterichthys macrocephalus, *Egerton*, sp.		Quart. Journ. Geol. Soc., vol. xviii, p. 103, pl. iii, figs. 7—9, text-figs. 1—3.
1888.	Bothriolepis —	*R. H. Traquair.*	Geol. Mag. (3), vol. v, p. 510, and Ann. and Mag. Nat. Hist. (6), vol. ii, p. 501.
1891.	— macrocephala,	*A. S. Woodward.*	Cat. Foss. Fishes Brit. Mus., pt. ii, p. 231.

Specific Characters.—Length not much over one inch; head large, measuring about two thirds the length of the dorsal surface of the body carapace; dorsal aspect of the body broad, ventral flat portion comparatively narrow; median ventral plate small; external surface of plates minutely pitted, reticulate; outer margin of proximal segment of arm distinctly serrated.

Description.—The specimen represented in Pl. XXX, Fig. 4, shows the dorsal surface with the head, but the last-named part looks almost like a ring, as the bone is largely injured and lost over the central region. Nevertheless, we are struck by the large size of the head, which shows a length equal to two thirds of that of the body carapace. The sculpture of the plates of the body is lost. The right pectoral appendage is shown, but in the drawing it has not been made long enough; some evidence of the marginal denticulation is shown on the outer aspect of the proximal portion (British Museum, P. 606).

Fig. 5 shows the creature from the ventral aspect, and the narrow contour

of the undermost flat surface is well seen, while the outlines of the anterior and posterior ventro-lateral and median ventral plates are clearly traceable. The outer surface of the plates being lost, the sculpture is, of course, also invisible. Both pectoral appendages are exhibited, and the finely denticulated or serrated outer edge of the proximal segment is well seen in the appendage of the left side (British Museum, P. 196).

In Fig. 6 we have also the under surface of the animal, and its contour looks broader on account of some amount of special pressure and flattening to which the specimen has been subjected. In this example the denticulation of the outer margin of the proximal part of the arm is seen to be proportionally just as strong as in *B. hydrophila* (British Museum, 36442).

The specimen in the British Museum (P. 195), from which fig. 9, pl. iii, in Egerton's description is taken, but which is not reproduced here, shows a sharp impression of the outer surfaces of the anterior ventro-lateral plates, and of a portion of the left pectoral appendage, which impression is minutely tuberculated, showing that the original sculpture of the plates themselves must have been of a finely pitted character, resembling that of *B. hydrophila*.

Remarks.—Originally described as a *Pterichthys*, this small Asterolepid was transferred by myself to *Bothriolepis*, and its resemblance to *B. hydrophila* is so great that it is designated by Dr. Smith Woodward in his 'Catalogue' as "a variety or species, so far as known, merely differing from the typical *B. hydrophila* in its much smaller size." However, the head, as indicated by Sir Philip Egerton's specific name "*macrocephala*," seems to be proportionately larger than in the Dura Den form, and so it may rest as a distinct species in the meanwhile.

Sir Philip Egerton, in his original paper on this form, appealed to appearances presented by the specimens he examined, and which are now all in the British Museum, in support of his view, that the pectoral appendages of "*Pterichthys*" were borne on a pair of "thoracic" plates separated by suture from the anterior ventro-laterals. The fact is that, the bony matter of these plates being pretty much scaled off, the *impression* of the *internal transverse ridge*, which passes across the anterior ventro-lateral plate, a little behind the front, comes into view, which impression on superficial examination is misleadingly suggestive of an actual division. The non-existence of the so-called thoracic plates was amply proved by myself for the Asterolepidæ in general in 1888.

Geological Position and Locality.—The only known specimens have been found in the yellow sandstone (Upper Old Red) of Farlow, in Shropshire.

Bothriolepis cristata, *Traquair*. Plate XXXI.

1896. Bothriolepis cristata, *R. H. Traquair*. In Harvie-Brown and Buckley's Vert. Fauna Moray Basin, p. 266, pl. ix.

Specific Characters.—Dorsal surface furnished with an elevated laminar median crest, rising from the posterior half of the anterior median dorsal plate and the anterior half of the posterior median dorsal; sculpture of plates finely tuberculo-reticulate.

Description.—Shortly before his lamented death the late Rev. Dr. Gordon showed me a specimen of *Bothriolepis* from Rosebrae, near Elgin, with the appearance of which I was immediately struck. The body carapace with what remained of the head, being removable from the matrix, was in a singularly uncompressed state; the back, having only received a slight oblique squeeze from left to right, was seen to be more lofty in shape than is usual in the species of this genus, while the matrix showed apparently the impression of an elevated laminar crest rising from the middle line of the dorsal surface. Shortly afterwards Mr. William Taylor, of Lhanbryde, procured from the same quarry two specimens showing the impression of part of the back in such a way as clearly to prove the existence of this singular crest.

Dr. Gordon's specimen has been already figured by me in Harvie-Brown and Buckley's 'Fauna of the Moray Basin.' It is now in the Elgin Museum, to the Directors of which I am indebted for a second loan of it for the purpose of this monograph. Mr. Taylor kindly presented his specimens to the Royal Scottish Museum.

Fig. 2, Pl. XXXI, shows the specimen first referred to, still in the matrix, and seen from the right lateral aspect, whereby the unusual height (for *Bothriolepis*) of the sides is brought into view. This is seen to be due to the considerable relative depth of the lateral portions of the anterior and posterior dorso-lateral plates as compared with the condition in such species as *B. major*, *Canadensis*, or *hydrophila*. Then on the matrix at c, the impression of the dorsal crest is seen arising from the middle line of the anterior median dorsal (*a. m. d.*) just behind the centre of the plate, whence it is continued backwards over two thirds of the extent of the posterior median dorsal (*p. m. d.*); the crest itself is highest about the middle third, and falls away gently both in front and behind.

In Fig. 1 we have the specimen removed from the matrix and seen from the dorsal aspect. This view requires little comment, except that the carapace appears slightly narrower in proportion to its length than is ordinarily the case in *Bothriolepis*. The head is much injured and presents no points for description.

PLATE XXVII.

(The cost of this plate has been defrayed by the Carnegie Trust for the Universities of Scotland.)

Fig.

1. Imperfect anterior median dorsal plate of *Bothriolepis obesa*, from the neighbourhood of Jedburgh. The bony matter has extensively flaked off, so that only feeble traces of the external sculpture remain.

2. Anterior median dorsal plate, internal surface. From a plaster mould of an impression from Rule Water, near Jedburgh. Collection of Geological Survey of Scotland.

3. Fragment of an anterior median dorsal plate, outer surface showing sculpture. From a plaster mould of an impression from Harelaw, Chirnside, Berwickshire. Hugh Miller Collection.

4. Left posterior dorso-lateral plate, showing external sculpture and the areæ overlapped by the anterior dorso-lateral, the posterior ventro-lateral, and the posterior median dorsal; a considerable portion of the plate is unfortunately deficient at the anterior superior (or internal) angle. From a plaster mould taken from an impression from Harelaw, Chirnside, Berwickshire. Hugh Miller Collection.

5. Fragment of the proximal segment of a pectoral appendage placed horizonally, showing portion of the articular, internal marginal, and external marginal plates, seen from their internal surfaces. Note the stout denticulations on the outer aspect of the external marginal. From Harelaw, Chirnside, in the Hugh Miller Collection.

6. Part of the median occipital and post-median plates showing external sculpture. From a plaster mould taken from an impression from Harelaw, Chirnside, in the Hugh Miller Collection.

All these figures are two thirds natural size, and with the exception of that of Fig. 2, all the originals are in the collection of the Royal Scottish Museum.

PLATE XXVII

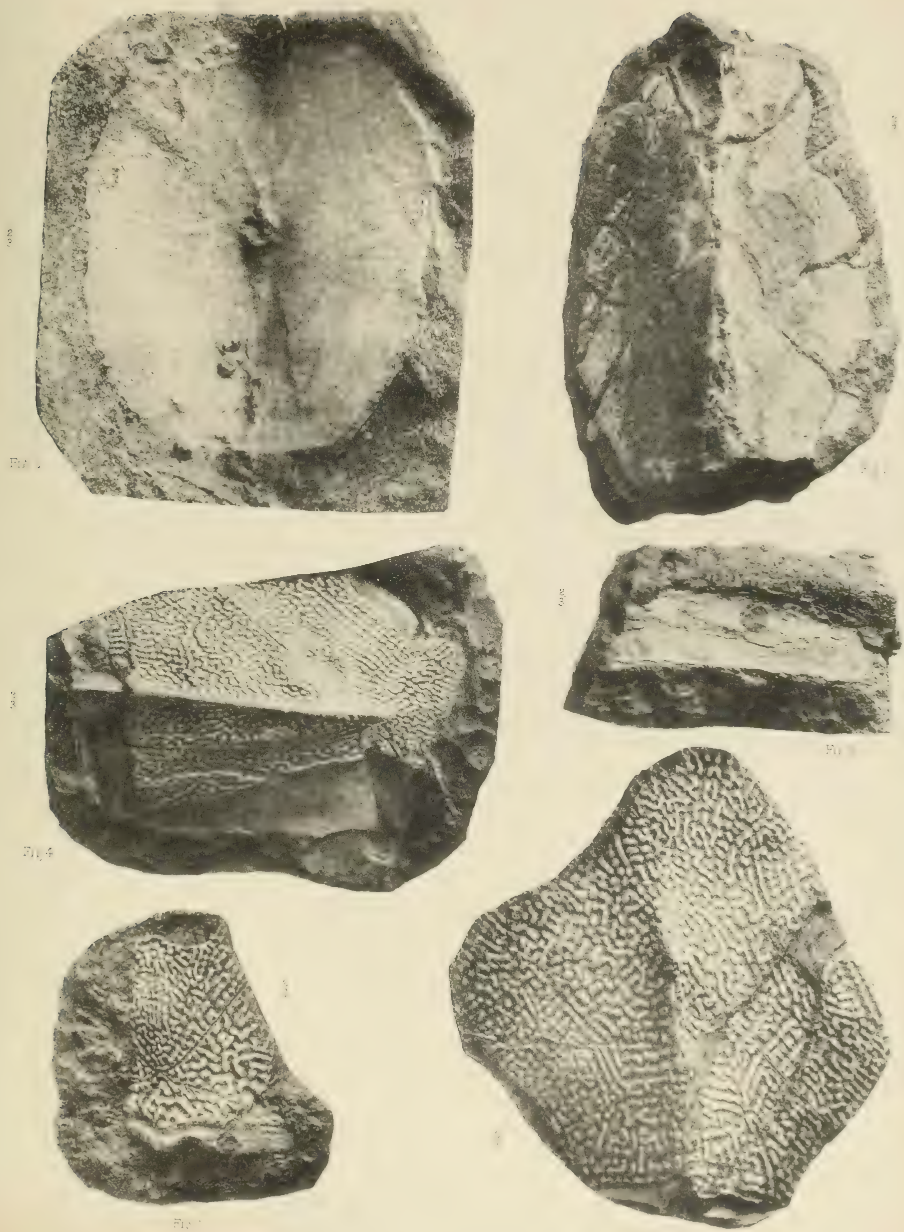


PLATE XXVIII.

(The cost of this plate was defrayed by the Carnegie Trust for the Universities of Scotland.)

Fig.

1. Right anterior ventro-lateral plate of *Bothriolepis obesa*, deficient at posterior margin. From Jedburgh, in the Powrie Collection, Royal Scottish Museum.

2. Left anterior ventro-lateral plate, somewhat deficient in front of the articular fossa for the pectoral appendage; *b. p.* brachial process. Rule Water, Jedburgh, in the Collection of the Geological Survey of Scotland.

3. Imperfect left ventro-lateral plate, seen from below. From Rule Water, Jedburgh, also in the Collection of the Geological Survey of Scotland.

4. The same specimen seen from the outer side.

5. Right posterior dorso-lateral plate, seen from the outer side, but owing to flaking off of the surface the sculpture is nearly completely lost. From the neighbourhood of Jedburgh, in the Royal Scottish Museum.

All these figures are two thirds natural size.

7/12

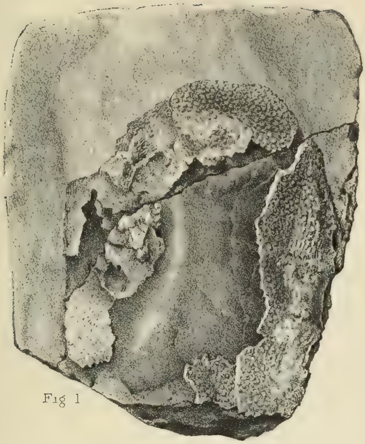


Fig 1

2/3

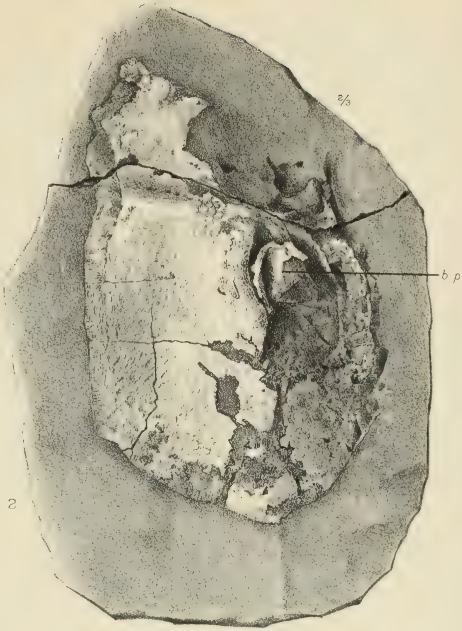


Fig 2

2/3

Fig 5.

2/3

Fig. 4.

2/3

Fig 3

J. Green del. et lith.

Bale & Danielsson, Ltd imp.

PLATE XXIX.

(The cost of this plate was defrayed by the Carnegie Trust for the Universities of Scotland.)

Fig.

1. *Bothriolepis leptocheirus*, premedian plate. Heads of Ayr, in the Hugh Miller Collection.

2. Fragment of the articular extremity of a pectoral appendage, outer side, showing the two articular plates meeting over the proximal end of the external marginal. Same locality and collection.

3. Right anterior ventro-lateral plate, external surface. Attached to it is the proximal portion of the corresponding pectoral appendage, but split open, so as to show the internal surface of its dorsal elements.

4. Portion of rock showing an articular plate of the pectoral appendage and an imperfect posterior median dorsal. The latter is lying so that its posterior extremity points upwards. Same locality and collection.

5. Terminal segment of a pectoral appendage.

All the figures on this plate are of the natural size, and the originals are the property of the Royal Scottish Museum.

Fig. 5

Fig. 1

Fig. 2

PLATE XXX.

(The cost of this plate has been defrayed by the Carnegie Trust for the Universities of Scotland.)

FIG.

1. *Bothriolepis hydrophila*, portion of a slab which was given by the late Rev. Dr. Anderson of Newburgh to the Highland and Agricultural Society, and is now in the Royal Scottish Museum. On the right side is an entire specimen, seen from the ventral aspect; on the left is a sharp impression of the dorsal surface of another, but wanting the "arms." From Dura Den, near Cupar, in Fifeshire.

2. *Bothriolepis hydrophila*. Nearly perfect specimen of the dorsal surface of the head and carapace. From the same locality, and also belonging to the Royal Scottish Museum.

3. Anterior median dorsal plate of a small *Bothriolepis*, from Clashbennie, in Perthshire, and which seems in all probability to be referable to *B. hydrophila*. Roughly figured by Fleming in 1831 (see page 126). Fleming Collection, Royal Scottish Museum.

4. *Bothriolepis macrocephala*. One of Sir Philip Egerton's types, and already figured by him (see page 128). Egerton Collection, British Museum (Natural History). From Farlow, Shropshire.

5. The same species—body, with pectoral appendages, seen from the ventral aspect. Farlow, Shropshire. Weaver-Jones Collection, British Museum (Natural History).

6. The same species, ventral aspect. This is the second of the type specimens already figured by Sir Philip Egerton (see page 129). From Farlow. In the British Museum (Natural History).

All the figures on this plate are of the natural size.

Fig 1

Fig 2.

Fig 3

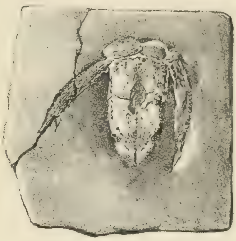


Fig 5

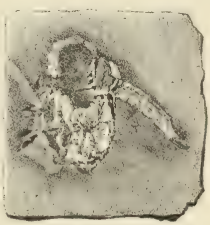


Fig 4

Fig 6

J. Green del. et lith.

Bale & Danielsson, Ltd imp.

PLATE XXXI.

The cost of this plate has been defrayed by the Carnegie Trust for the Universities of Scotland.)

Fig.

1. *Bothriolepis cristata*, removed from the matrix, dorsal view. For explanation of lettering see restored outline of *B. Canadensis* on p. 112. Rosebrae Quarry, Elgin, in the Elgin Museum.

2. The same specimen replaced in the matrix and seen from the right side, the impression of the median crest being seen at *C*.

3. Impression of the ventral surface of the same specimen, showing the pectoral appendages, which, however, are imperfect.

4. Fragment of an impression of the dorsal aspect of *Bothriolepis cristata*, showing the deep narrow slit left by the median dorsal crest. From Rosebrae, in the Royal Scottish Museum, to which it was presented by William Taylor, Esq., Lhanbryde.

All the figures on this plate are of the natural size.

Fig. 3.

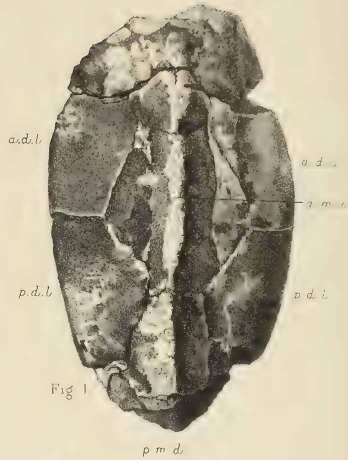


Fig 1

Fig 2.

Fig 4.

J.Green del. et lith

Bale & Danielsson

Palæontographical Society, 1906.

A MONOGRAPH

OF THE

CRETACEOUS LAMELLIBRANCHIA

OF

ENGLAND.

BY

HENRY WOODS, M.A.

UNIVERSITY LECTURER IN PALÆOZOOLOGY, CAMBRIDGE.

VOL. II. PART III.

PINNIDÆ ASTARTIDÆ, CARDITIDÆ, CRASSATELLITIDÆ. AND CYPRINIDÆ.

Pages 97—132; Plates XII—XIX.

LONDON:

PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.

1906.

PRINTED BY ADLARD AND SON, LONDON AND DORKING.

? 1888. PINNA ROBINALDINA, *P. Choffat.* Stratigr. et Paléont. d'Angola (Mém. Soc. phys. et d'hist. nat. de Genève, vol. xxx, No. 2), p. 86, pl. v, figs. 4, 5.

? 1903. — — *C. Burckhardt.* Jura u. Kreidef. d. Cordillere (Palæontographica, vol. l), p. 79, pl. xv, figs. 6, 7.

? 1905. — *cf.* ROBINALDINA, *E. Harbort.* Fauna d. Schaumburg-Lippe'schen Kreidemulde (Abhandl. d. k. preussisch. geol. Landesanst., N.F., Heft 45), p. 47, pl. v, fig. 5; pl. vii, figs. 2, 3.

Description.—Shell straight, much elongated; pyramidal, slightly compressed; margins nearly straight; section sub-quadrangular.

Each valve is divided into two parts, which meet at an angle. The dorsal part is smaller and more flattened than the ventral part, and is ornamented with from 6 to 8 or more ribs, which are narrow, strong, and nearly equi-distant. The ribs are separated by broad, shallow, rounded depressions; both depressions and ribs are crossed by very fine, somewhat irregular, concentric ridges, which sometimes give a slightly serrated appearance to the ribs. The ventral part of each valve is moderately convex, and its dorsal portion is ornamented with from 5 to 7 radial ribs similar to those on the dorsal part of the valve, but decreasing in size ventrally; the last one or two of these ribs sometimes become irregular and discontinuous. These radial ribs and their interspaces are crossed by fine concentric ridges. The ventral portion of the ventral part of the valve is ornamented with strong growth-ridges or folds, which curve rapidly in the direction of the umbo, and form an acute angle where they meet the ribs.

Measurements:

	(1)	(2)
Length .	135 .	94 mm.
Height .	49 .	41 „

(1) *Perna*-bed, Atherfield.

(2) *Crioceras*-bed, Whale Chine.

Affinities.—The figure of *P. gracilis*, Phillips,[1] is not sufficiently good to enable one to form a satisfactory idea of the character of the species, and the type cannot now be found. But other specimens from Speeton, although very imperfectly preserved, are sufficient to suggest that *P. gracilis* is probably identical with *P. Robinaldina.*

It is suggested by Pictet and Campiche that *P. tetragona*, Sowerby,[2] from the

[1] 'Geol. Yorks.' (1829), p. 122, pl. ii, fig. 22.

[2] 'Min. Conch.,' vol. iv (1821), p. 9, pl. cccxiii, fig. 1; Morris, 'Cat. Brit. Foss.,' ed. 2 (1854), p. 180; *P. subtetragona*, d'Orbigny, 'Prodr. de Pal.,' vol. ii (1850), p. 165; Pictet and Campiche, 'Terr. Crét. Ste. Croix' (1867), p. 537; non *P. tetragona*, Brocchi, 1814.

Upper Greensand of Devizes, is probably identical with *P. Robinaldina*. The specimens from Devizes agree with those found at Blackdown in having the folds on the ventral part of the valve rather more strongly marked than in *P. Robinaldina* from the Lower Greensand. In other respects the Upper Greensand form does not appear to differ from *P. Robinaldina*, and may be regarded as a variety of it, *P. Robinaldina* var. *tetragona*, Sowerby.

P. Reynesi, Hébert and Munier-Chalmas,[1] is similar to *P. Robinaldina*, but apparently differs in that the ribs on the ventral part of the shell are all smaller than those on the dorsal part, and do not diminish gradually in size.

P. cretacea (Schlotheim)[2] is closely related to *P. Robinaldina*, but appears to be distinguished (1) by the ribs covering a larger proportion of the ventral part of the shell and being of nearly uniform size, (2) by the growth-lines on the ventral part being more nearly straight, (3) by the shell being usually more elongate.

Remarks.—The specimens of *Pinna* found in the Gault of Folkestone and Black Ven have usually been named *P. tetragona*. Their mode of preservation is more or less unsatisfactory, owing to crushing and to the absence of some of the outer layers of the shell, but after a close comparison with examples of *P. Robinaldina* from the Lower Greensand I am unable to see any reason for regarding the former as specifically distinct from the latter.

Pictet and Campiche thought that the examples from Blackdown were referable to *P. Robinaldina*, differing only in having the folds on the ventral part of the shell rather more strongly marked.

The specimens from the Lower Greensand of the Isle of Wight agree well with the figures given by Pictet and Renevier and by Pictet and Campiche. The number of ribs varies considerably, and in young specimens the apical angle is smaller than in older examples.

A specimen from the Upper Greensand of Ventnor, which has been referred[3] to *P. Reynesi*, Hébert and Munier-Chalmas, is probably a crushed example of *P. Robinaldina*.

Type.—The type of *P. rugosa* came from the Hils-conglomerate of Osterwald. The type of *P. tetragona*, Sowerby, came from the Upper Greensand of Devizes and is now in the British Museum.

Distribution.—*Perna*-bed, Crackers, and Fitton's Beds 16 and 38, of Atherfield. Ferruginous Sands of Shanklin. Atherfield Beds of Redhill, Reigate. Sandgate Beds of Parham Park. Lower Greensand of Brickhill. ?Speeton Clay (zone of *Belemnites brunsvicensis*) of Speeton. Gault of Folkestone and Black Ven.

[1] 'Ann. Sciences géol.,' vol. vi (1875), p. 118, pl. v, fig. 10.

[2] Geinitz, 'Das Elbthalgeb.' (Palæontographica, vol. xx, pt. 2, 1873), p. 54, pl. xiv, figs. 2, 3.

[3] Jukes-Browne, 'Cret. Rocks of Britain,' vol. i (1900), p. 470.

Upper Greensand (zone of *Schlœnbachia rostrata*) of Blackdown, Devizes, and Ventnor.[1]

Pinna, sp. Plate XIII, figs. 2, 3.

Some specimens of *Pinna* found in the Gault of Folkestone differ from *P. Robinaldina* in having smaller and more numerous ribs, which are crossed at regular intervals by narrow concentric ridges.

Pinna tegulata, *Etheridge*, 1881.

1881. Pinna tegulata, *R. Etheridge*, in *Penning and Jukes-Browne's* Geol. Cambridge (Mem. Geol. Survey), p. 142, pl. i, fig. 2.

Remarks.—This species is known only by the type and a few fragmentary specimens. The type shows the interior of a right valve. The ornamentation appears to be similar to the form from the Gault described above. On the dorsal half of the valve there are about 18 narrow ribs, which are crossed at regular intervals by concentric ridges, giving rise to a fimbriated appearance. About 8 similar ribs are found on the dorsal part of the ventral half of the valve, below which are strongly curved growth-ridges.

Type.—In the Sedgwick Museum, Cambridge.

Distribution.—Totternhoe Stone (zone of *Holaster subglobosus*) of Burwell.

Pinna decussata, *Goldfuss*, 1837. Plate XIII, figs. 4 *a–c*, 5, 6. Plate XIV, fig. 1.

1833. Pinna sulcata, *S. Woodward.* Geol. Norfolk, p. 47, pl. v, fig. 23.
1837. — decussata, *A. Goldfuss.* Petref. Germ., vol. ii, p. 166, pl. cxxviii, figs. 1, 2.
— — compressa, *Goldfuss.* Ibid., p. 167, pl. cxxviii, fig. 4.
? 1840. — pyramidalis, *H. B. Geinitz.* Char. d. Schicht. u. Petref. des sächs. Kreidegeb., pt. 2, p. 55, pl. x, fig. 1,
— — compressa, *Geinitz.* Ibid, p. 55.
1841. — fenestrata, *F. A. Römer.* Die Verstein. d. nord-deutsch. Kreidegeb., p. 65, pl. viii, fig. 22.
— — decussata, *Römer.* Ibid., p. 65.
1846. — pyramidalis, *H. B. Geinitz.* Grundr. d. Verstein., p. 451.

[1] I have not seen any specimen of *Pinna* ? *crassa*, Fitton, 'Trans. Geol. Soc.,' ser. 2, vol. iv (1836), p. 130; Morris, 'Cat. Brit. Foss.,' p. 180.

1846. Pinna decussata, *A. E. Reuss.* Die Verstein. der böhm. Kreideformat., pt. 2, p. 14, pl. xxxvii, figs. 1, 2.
1850. — — *A. d'Orbigny.* Prodr. de Pal., vol. ii, p. 165.
— — fenestrata, *d'Orbigny.* Ibid., p. 246.
— — decussata, *J. de C. Sowerby*, in *F. Dixon.* Geol. Sussex, p. 355 (p. 386, ed. 2), pl. xxviii, fig. 20.
— — diluviana, *H. B. Geinitz.* Das Quadersandst. oder Kreidegeb. in Deutschland, p. 166.
— — fenestrata, *Geinitz.* Ibid., p. 166.
1854. — decussata, *J. Morris.* Cat. Brit. Foss., ed. 2, p. 180.
— — sulcata, *Morris.* Ibid., p. 180.
1873. — decussata, *H. B. Geinitz.* Das Elbthalgeb. in Sachsen (Palæontographica, vol. xx), pt. i, p. 211, pl. xlvii, figs. 4, 5; pt. ii, p. 53, pl. xv, figs. 2, 3; pl. xvi, fig. 1.
1877. — — *A. Fritsch.* Stud. im Gebiete der böhm. Kreideformat., ii. Weissenberg. u. Malnitz. Schicht., p. 120, fig. 86.
1883. — — *Fritsch.* Ibid., iii. Iserschicht., p. 104.
1888. — — *G. Müller.* Mollusk. d. untersen. v. Braunschweig (Jahrb. d. k. preussisch. geol. Landesanst. für 1887), p. 420.
1889. — — *Fritsch.* Stud. im Gebiete der böhm. Kreideformat., iv. Teplitz. Schicht., p. 79.
? 1890. — — *M. Blanckenhorn.* Beitr. z. Geol. Syriens: Kreidesyst. in Mittel u. Nord-Syrien, p. 80.
1893. — — *Fritsch.* Stud. im Gebiete der böhm. Kreideformat., v. Priesen. Schicht., p. 94.
1897. — — — Ibid., vi. Chlomek. Schicht., p. 57.
? 1894. — *cf.* decussata, *A. Hennig.* Om Åhussandst. (Geol. Fören. i Stockholm Förhandl., vol. xvi), p. 522.
1902. — decussata, *J. P. J. Ravn.* Mollusk. i Danmarks Kridtaflej., i. Lamellibr., p. 104.

Non 1846. — — *E. Forbes.* Trans. Geol. Soc., ser. 2, vol. vii, p. 153 (= *P. arata*, Forbes).

Description.—Shell moderately elongate, triangular, laterally compressed, section rhombic, but becoming lenticular in the later portion. Dorsal margin straight, ventral margin slightly curved.

Each valve is divided into two nearly equal parts. The dorsal part is flattened and bears from 7 to 9 strong rounded ribs, separated by broad, shallow, rounded depressions. The distance between the ribs increases in passing from the apex to the posterior extremity. In well-preserved specimens linear ridges are seen crossing the ribs and interspaces at regular intervals. The dorsal portion of

the ventral part of the valve bears from 5 to 7 ribs similar to those on the dorsal part and of nearly uniform size, with transverse linear ridges. On the ventral portion of the ventral part of the valve there are strong ridges or folds which form an acute angle with the last rib, and curve slightly towards the umbo.

Measurements (*approximate*) :

		(1)		(2)		(3)
Length	.	125	.	117	.	120 mm.
Height	.	66	.	69	.	66 ,,

(1) Chalk Marl, Folkestone.
(2) Chalk, Newtimber (Sussex).
(3) Chalk, Trimingham.

Remarks.—Most of the specimens of *Pinna* from the Chalk are very imperfectly preserved, and it is not unlikely that better material would show that more than one species could be distinguished.

In the examples from Trimingham the ribs are rather broader and more rounded than in most of the specimens found at lower horizons.

Affinities.—This species is less elongate than *P. cretacea* (Schlotheim),[1] and has the ridges on the ventral part of the valves more distinctly curved than in that form. It has a larger apical angle than *P. Robinaldina* (see p. 96) ; also the shell is rather more compressed, and the ribs on the ventral part do not decrease regularly in size as they do in *P. Robinaldina.*

P. sulcata, Woodward (Plate XIV, fig. 1), from the Norwich Chalk, as was suggested by J. de C. Sowerby, does not differ from *P. decussata.* Woodward's name is prior to that of Goldfuss, but since the original figure was scarcely sufficient for the recognition of the species and was not accompanied by any description, I do not think it is desirable that the well-known name *P. decussata* should be displaced by *P. sulcata.*

Most of the English specimens of *P. decussata* agree better with the figures given by Geinitz (1873) than with those of Goldfuss and Reuss. But the example figured by Dixon seems to be very similar to the types of Goldfuss.

Types.—From the Quadersandstone of Haltern (Westphalia) and Schandau (Saxony). The specimen figured by Dixon cannot be found. The type of *P. sulcata* is in the Norwich Museum.

Distribution.—Chalk Marl of Ventnor and Folkestone. *Terebratulina* zone of Arn Hill near Warminster. Zone of *Holaster planus* of Balsham. Chalk of Newtimber. Zone of *Micraster cor-anguinum* of Charlton and Gravesend. Upper Chalk (zone of *M. cor-testudinarium* or *M. cor-anguinum*) of Swaffham, Norfolk. (?) Zone of *Actinocamax quadratus* of East Harnham near Salisbury. Zone of *Belemnitella mucronata* of Norwich. Chalk of Trimingham.

[1] Geinitz, 'Das Elbthalgeb.,' pt. ii (1873), p. 54, pl. xiv, figs. 2, 3.

Family—ASTARTIDÆ, *Gray*.

Genus—Astarte, *J. Sowerby*, 1816.

('Min. Conch.,' vol. ii, p. 85.)

Astarte elongata, *d'Orbigny*, 1844. Plate XIV, figs. 2 *a*, *b*, 3.

1842. Astarte oblongata, *Deshayes* in *A. Leymerie*. Mém. Soc. géol. de France, ser. 2, vol. v, pp. 5, 24, pl. vi, fig. 1 (non *oblonga*, Sowerby, 1826).
1844. — elongata, *A. d'Orbigny*. Pal. Franç. Terr. Crét., vol. iii, p. 68, pl. cclxiii, figs. 8—11.
1850. — — *d'Orbigny*. Prodr. de Pal., vol. ii, p. 77.
1855. — — *G. Cotteau*. Moll. Foss. de l'Yonne, p. 69.
1866. — — *F. J. Pictet and G. Campiche*. Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 4), p. 310, pl. cxxiv, figs. 8, 9.
1868. — — *P. de Loriol*. Valangien d'Arzier, p. 28, pl. ii, fig. 7.
1871. — — *F. Stoliczka*. Palæont. Indica, Cret. Fauna S. India, vol. iii, p. 285.
1900. — — *A. Wollemann*. Die Biv. u. Gastrop. d. deutsch. u. holländ. Neocoms (Abhandl. d. k. preussisch. geol. Land., N. F., pt. 31), p. 102.

Description.—Shell thick, elongate, rounded-oblong or oval, convex, compressed, very inequilateral. Postero-dorsal margin curving ventrally to join the obtuse and slightly curving posterior margin. Postero-ventral extremity rounded. Ventral margin nearly straight. Anterior margin rounded. Umbones small, with an indistinct keel passing from them towards the postero-ventral extremity. Lunule narrow.

Ornamentation consists of strong concentric ribs, somewhat unequal in size, and separated by narrow grooves. Margins of valves crenulated.

Length 21 mm.; height 22 mm.

Affinities.—*Astarte cingulata*, Geinitz,[1] from the Cenomanian of Plauen, is probably identical with this species.

A. elongata is easily distinguished from other Cretaceous species by its elongate form.

Remarks.—The only specimens seen are in the Museum of Practical Geology.

[1] 'Das Elbthalgeb. in Sachsen' (Palæontographica, vol. xx, pt. i, 1873), p. 226, pl. l, fig. 8. Non *A. cingulata*, Contejean, 'Kimmérid. de Montbéliard' (1859), p. 267, pl. xi, figs. 5—7.

One has the shell preserved, the others are internal casts showing deep muscular impressions.

Types.—Leymerie's specimens came from the Lower Neocomian of Avalleur, Chenay, and Marolles (Aube). D'Orbigny records specimens from the Lower Neocomian of St. Sauveur (Yonne). Pictet and Campiche figure specimens from the Valanginian of Ste. Croix.

Distribution.—Lower Greensand of Seend.

Astarte subacuta, *d'Orbigny*, 1850. Plate XIV, figs. 4—6.

1844.	Astarte carinata, *A. d'Orbigny.*			Pal. Franç. Terr. Crét., vol. iii, p. 63, pl. cclxii, figs. 1–3. (non *A. carinata*, Phillips, 1829.)
1847.	—	acuta, *d'Orbigny.*		Ibid., p. 759. (non *A. acuta*, Reuss, 1846.)
1850.	—	subacuta, *d'Orbigny.*		Prodr. de Pal., vol. ii, p. 77.
1866.	—	—	*F. J. Pictet and G. Campiche.*	Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 4), p. 318.
1900	—	—	*A. Wollemann.*	Die Biv. u. Gastrop. d. deutsch. u. holländ. Neocoms (Abhandl. d. k. preussisch. geol. Land., N. F., pt. 31), p. 99.

Description.—Shell triangular, much compressed, length greater than height, slightly inequilateral. Antero-dorsal margin long and concave. Postero-dorsal margin longer than the antero-dorsal, and either concave or nearly straight. Both of these margins form obtuse angles with the well-rounded margin of the ventral half of the shell. Umbones very acute, projecting, often nearly median and not curved. Lunule narrow, with a sharp edge. Escutcheon very narrow.

Ornamentation consists of prominent concentric ribs separated by broad interspaces. The distance between the ribs increases in passing from the umbo ventrally. Margins of valves crenulated.

Measurements :

	(1)	(2)
Length .	14 .	10 mm.
Height .	11 .	8 ,,

(1, 2) *Perna*-bed, East Shalford.

Affinities.—*A. subacuta* is distinguished from the other Cretaceous species by its acute umbones and flattened valves.

Remarks.—The only specimens which I have seen are in the Meÿer Collection, Sedgwick Museum.

Type.—From the Neocomian of Brienne (Aube).

Distribution.—*Perna*-bed of East Shalford. Atherfield Beds of Sevenoaks.

Astarte sinuata, *d'Orbigny*, 1844. Plate XIV, figs. 7—9.

1844. Astarte sinuata, *A. d'Orbigny*. Pal. Franç. Terr. Crét., vol. iii, p. 69, pl. cclxiv, figs. 1—3.
1850. — — *d'Orbigny*. Prodr. de Pal., vol. ii, p. 118.
1856. — — *F. J. Pictet and E. Renevier*. Foss. Terr. Aptien (Matér. Pal. Suisse, ser. 1), p. 89, pl. x, fig. 3.
1866. — — *F. J. Pictet and G. Campiche*. Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 4), p. 311.
1871. — — *F. Stoliczka*. Palæont. Indica, Cret. Fauna S. India, vol. iii, pp. 251, 285.
1895. — — *G. Maas*. Zeitschr. d. deutsch. geol. Gesellsch., vol. xlvii, p. 261.
1900. — — *A. Wollemann*. Die Biv. u. Gastrop. d. deutsch. u. holländ. Neocoms (Abhandl. d. k. preussisch. geol. Land., N. F., pt. 31), p. 100.

Description.—Shell sub-quadrate, rounded ventrally, truncated posteriorly, longer than high, slightly or moderately inequilateral, much compressed. A furrow extends from just behind the umbo to the sinuosity on the posterior margin, and cuts off a triangular, flattened, postero-dorsal part of the valve. Antero-dorsal margin nearly straight. Anterior margin rounded, passing gradually into the curved ventral margin. Posterior margin with a sinuosity above the postero-ventral angle. Postero-dorsal margin straight or slightly concave, longer than the antero-dorsal margin, and forming an angle with the posterior margin. Umbones pointed, inconspicuous. Lunule and escutcheon long, narrow, with sharp edges which have tooth-like projections where the ribs end.

Ornamentation consists of rounded, concentric ribs separated by shallow furrows. The ribs are rather stronger on the posterior than on the anterior part of the shell, and are sinuous where they cross the posterior furrow. Smaller ribs are present on the main ribs and furrows.

Measurements :

	(1)	(2)
Length . . .	16 . .	15 mm.
Height . . .	14·5 . .	14 „
Thickness . .	4· . .	

(1, 2) Crackers, Atherfield.

Affinities.—*A. sinuata* is distinguished from other Cretaceous species of *Astarte* by the furrow passing from the umbo to the posterior margin. Conrad[1] thought that this species might belong to his genus *Lirodiscus.* I am unable to express an opinion on this matter, since I have seen only three examples, none of which shows the hinge, nor is it seen in the figures given by previous writers.

Type.—From the Aptian of Marolles (Aube).

Distribution.—Lower Greensand (Crackers) of Atherfield. Recorded by Pictet and Renevier from the Lower Greensand of Peasmarsh.

Astarte upwarensis, sp. nov. Plate XIV, figs. 10 *a–c*, 11 *a*, *b*, 12.

1883. Astarte, sp. nov., *W. Keeping.* Foss., etc., Neoc. Upware and Brickhill, p. 122, pl. vi, fig. 9.

Description.—Shell ovate, a little higher than long, moderately and evenly inflated, moderately (or sometimes only slightly) inequilateral. Dorsal half narrowing gradually to the umbo; ventral half larger and with evenly-rounded margin. Antero-dorsal border slightly concave; postero-dorsal border long and convex. Umbones curving forward. Lunule large, ovate, depressed, with a sharp border. Escutcheon lanceolate, with a sharp edge.

Ornamentation consists of many flattened, inconspicuous, concentric ribs separated by linear grooves.

Measurements :

	(1)	(2)	(3)	(4)	(5)
Length .	24 .	21 .	19 .	14 .	13 mm.
Height .	25 .	21·5 .	21 .	15 .	14 ,,

(1–5) Lower Greensand, Upware.

Affinities.—This species presents some resemblance to *A. valangiensis*, Pictet and Campiche,[2] but its dorsal half is not so narrow and pointed, and the antero-dorsal margin is less concave. It is also similar to *A. Rhodani*, Pictet and Campiche,[3] from the Gault of Cosne, but the umbones are less prominent.

Astarte upwarensis is distinguished from *A. circularis*, Guéranger,[4] by its ovate outline and greater height.

Type.—Of the specimens of this species which were figured by W. Keeping as

[1] 'Amer. Journ. Conch.,' vol. v (1869), p. 46.

[2] 'Terr. Crét. Ste. Croix' (Matér. Pal. Suisse, ser. 4, 1866), p. 303, pl. cxxiii, figs. 3, 4.

[3] De Loriol, 'Gault de Cosne' (1882), p. 94, pl. xii, figs. 1–7.

[4] 'Album Paléont. de la Sarthe' (1867), p. 12, pl. xv, fig. 12, pl. xvi, figs. 7, 8.

Astarte, sp. nov., one is in the Sedgwick Museum (fig. 9 *a*), the other in Mr. J. F. Walker's collection (fig. 9 *b*).

Distribution.—Lower Greensand of Upware.

Astarte senecta, sp. nov. [ex *Bean* MS.] Plate XIV, figs. 13–20.

1889. Astarte senecta [Bean MS.] *G. W. Lamplugh.* Quart. Journ. Geol. Soc., vol. xlv, p. 616.

Description.—Shell subtriangular, or approaching subquadrangular, sometimes rounded, rather compressed, usually very inequilateral; height usually a little greater than length. Anterior margin rounded, ventral margin curving slightly and often forming a rounded angle with the posterior margin, which is slightly curved and usually makes an obtuse angle with the postero-dorsal margin. Umbones small, curving forwards. Lunule ovate, deep, with a sharp border. Escutcheon narrow, deep, with a sharp border.

Ornamentation consists of strong concentric ribs, with sharp summits, separated by broad furrows, on both of which are numerous small ribs. The ribs bend sharply in passing on to the postero-dorsal part of the valve, and cut the postero-dorsal margin obliquely. Margins of valves strongly crenulated.

Measurements :

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	
Length .	23	22	21	19	13	26	25	25	23	23	21	mm.
Height .	21·5	20	19	17	11	24	22·5	22	23	22	21	,,

(1–5) Speeton Clay, Speeton.

(6–11) Claxby Ironstone, Benniworth Haven.

Affinities.—*Astarte veneris*, Eichwald,[1] is similar to this species, but has a deeper and larger lunule, more prominent umbones, less compressed valves, and more slender ribs. Specimens of *A. veneris* from the 'Volgian' of Moscow are in Mr. Lamplugh's collection.

Remarks.—This species has been known to collectors for a long time, and has appeared in lists of fossils under the name *Astarte senecta*, Bean MS., but has not hitherto been described and figured.

The specimens from the Claxby Ironstone are, as a rule, more rounded in outline than those from Speeton, and their ornamentation is not so well preserved on account of the difficulty of separating the shells from the hard matrix in which they are found.

[1] D'Orbigny, in Murchison, de Verneuil, and de Keyserling, 'Géol. Russ. d'Europe,' vol. ii (1845), p. 456, pl. xxxviii, figs. 21, 22.

Distribution.—Zone of *Belemnites lateralis:* in the Speeton Clay of Speeton and the Claxby Ironstone of Benniworth Haven.

Astarte, sp. Plate XIV, fig. 21.

Description.—Shell oval, moderately convex, slightly inequilateral, length greater than height. Antero-dorsal margin concave. Anterior margin rounded, passing gradually into the curved ventral margin. Postero-dorsal margin convex, forming a rounded angle with the posterior margin. Umbo pointed.

Ornamentation consists of about 15 strong, rounded, concentric ribs separated by rounded furrows of greater breadth. Fine concentric ridges occur on both ribs and furrows. The ribs cut the postero-dorsal margin at a large angle; they are more widely separated on the dorsal than on the ventral half of the valve.

Length 12·5 mm.; height, 11·2 mm.

Remarks.—This species is known by a single right valve only. The ornamentation is somewhat similar to that of *A. senecta*, but the shell is more oval and less inequilateral, also the ribs are more numerous and form a larger angle with the postero-dorsal margin.

Distribution.—Speeton Clay of Speeton.

Astarte cantabrigiensis, sp. nov. Plate XIV, figs. 22*a*, *b*, 23*a*, *b*, 24.

1883. Astarte subdentata, *W. Keeping.* Foss., etc., Neoc. Upware and Brickhill, p. 122, pl. vi, fig. 11 (*non* Römer).

Description.—Shell subquadrate, longer than high, very inequilateral, moderately inflated, with the greatest convexity between the umbo and the postero-ventral angle. Postero-dorsal margin long, slightly convex, forming an obtuse angle with the truncated posterior margin, and a blunt angle where it joins the slightly convex ventral margin. Anterior margin rounded. Lunule deep, ovate, distinctly limited. Escutcheon deep, with a sharp edge.

Ornamentation consists of strong concentric ribs bearing finer ribs.

Measurements :

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	
Length .	17·5	15	15	14	14	13·5	13	12	mm.
Height .	16	13·5	13	12·5	12	12·5	11·5	10·5	,,

(1–8) Lower Greensand, Upware.

Affinities.—This species was identified by W. Keeping with *A. subdentata*, Römer,[1] from the Neocomian of Brunswick. I have submitted photographs of the British fossil to Dr. A. Wollemann and he agrees with me in thinking that it is quite distinct from *A. subdentata.* In the latter the shell is smaller, the valves are much flatter and more elongate, and the umbones are more pointed and less anterior in position.

The ornamentation, when well preserved, is somewhat similar to that of *A. senecta* (see above), but the shell is more inequilateral, more nearly quadrate in outline, and the postero-dorsal part is more compressed.

Remarks.—The ornamentation is often imperfectly preserved, and in some cases it has almost entirely disappeared. The hinge has not been seen.

Type.—The specimen figured by Keeping is in the Sedgwick Museum, Cambridge.

Distribution.—Lower Greensand of Upware.

Astarte claxbiensis, sp. nov. Plate XIV, figs. 25–28.

Description.—Shell small, thick, oval, longer than high, inflated, slightly inequilateral. Antero-dorsal margin concave, postero-dorsal slightly convex. Anterior margin well rounded. Ventral and posterior margins forming a regular curve. Umbones prominent, close together, nearly median, curved greatly inwards and slightly forwards. Lunule large, ovate, with sharp edges. Escutcheon lanceolate, smooth, distinctly limited.

Ornamentation consists of strong, narrow, concentric ribs, separated by broad, deep furrows. Left valve with two stout cardinal teeth and a tooth at the margin of the lunule. Margins of valves coarsely crenulate.

Measurements :

	(1)	(2)	(3)	(4)	(5)
Length .	12 .	11 .	10 .	9 .	8 mm.
Height .	10·5 .	10 .	9 .	8·25 .	7 ,,

(1–3, 5) Claxby Ironstone, Benniworth Haven.
(4) Spilsby Sandstone, Spilsby.

Affinities.—*Astarte claxbiensis* shows considerable resemblance to certain species found in the Jurassic rocks; thus *Astarte robusta*, Lycett,[2] from the Cornbrash, seems to differ only in having the valves more elongate and the umbonal parts narrower.

[1] 'Verstein. norddeutsch. Kreidegeb.' (1841), p. 71, pl. ix, fig. 9. Wollemann, 'Die Bivalven u. Gasterop. d. deutsch. u. holländ. Neocoms' (1900), p. 98, pl. v, fig. 2.

[2] 'Suppl. Mon. Mollusca Great Ool.,' etc. (1863), p. 74, pl. xxxv, fig. 6.

A. cordata, Trautschold,[1] is another example of the same type. *A. Sauvagei*, de Loriol,[2] from the Sequanian, is also similar to *A. claxbiensis*, but appears to be less elongate.

Distribution.—Spilsby Sandstone (zone of *Belemnites lateralis*) of Spilsby. Claxby Ironstone (zone of *B. lateralis*) of Benniworth Haven.

ASTARTE SUBCOSTATA, *d'Orbigny*, 1850. Plate XIV, figs. 29–36.

1842. ASTARTE LATICOSTA, *Deshayes*. In *A. Leymerie*, Mém. Soc. géol. de France, ser. 2, vol. v, p. 4, pl. iv, figs. 4, 5 (non *A. laticosta*, Deshayes, 1839).
1844. — STRIATO-COSTATA, *A. d'Orbigny*. Pal. Franç. Terr. Crét., vol. iii, p. 64, pl. cclxii, figs. 7–9 (non *A. striato-costata*, Römer, 1836).
1845. VENUS (?) [STRIATO-COSTATA], *E. Forbes*. Quart. Journ. Geol. Soc., vol. i, p. 241.
1850. ASTARTE SUBCOSTATA, *d'Orbigny*. Prodr. de Pal., vol. ii, p. 77.
1854. — STRIATO-COSTATA, *J. Morris*. Cat. Brit. Foss., ed. 2, p. 187.
1855. — SUBCOSTATA, *G. Cotteau*. Moll. Foss. de l'Yonne, p. 70.
1856. — LATICOSTA, *F. J. Pictet and E. Renevier*. Foss. Terr. Aptien (Matér. Pal. Suisse, ser. 1), p. 88, pl. x, fig. 2.
1865. — LEYMERII, *K. A. Zittel*. Die Bivalv. d. Gosaugeb. (Denkschr. d. k. Akad. Wien, Math.-nat. Classe, vol. xxiv), p. 156.
1865. — LATICOSTA, *H. Coquand*. Mon. Aptien de l'Espagne, p. 126.
1866. — SUBCOSTATA, *F. J. Pictet and G. Campiche*. Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 4), p. 307.
? 1868. — STRIATO-COSTATA, *E. Eichwald*. Lethæa Rossica, vol. ii, p. 624.
? 1868. — LATICOSTA, *Eichwald*. Ibid., p. 628.
? 1900. — LEYMERII, *G. Müller*. Deutsch-Ost-Afrika, vol. vii, p. 552, pl. xxii, figs. 4, 5.
1905. — SUBCOSTATA, *E. Harbort*. Die Fauna der Schaumberg-Lippe'schen Kreidemulde, p. 60, pl. iv, fig. 6.

Description.—Shell small, usually rather convex, subquadrate or subtriangular, moderately or very inequilateral. Antero-dorsal margin concave. Anterior and ventral margins rounded. Postero-dorsal margin long, nearly straight, forming an

[1] C. Rouillier, 'Bull. Soc. Nat. Moscou,' vol. xix, pt. 2 (1846), pl. D, fig. 15; pl. E, fig. 1; vol. xxi, pt. 1 (1848), pp. 274, 275. Trautschold, *Ibid.*, vol. xxxiii (1860), p. 347.

[2] De Loriol and Pellat, 'Mon. Paléont. et Géol. étages sup. Jurass. de Boulogne-sur-Mer' (1874), p. 96, pl. xv, figs. 33, 34.

angle with the posterior margin, which is more or less truncated. Umbones inconspicuous. Lunule smooth, ovate, rather broad, with a sharp edge. Escutcheon smooth, deep, long.

Ornamentation consists of 7 to 9 sharp, prominent, concentric ribs, with steep dorsal and gentle ventral slopes. Interspaces broad. Between the ribs there are three or four very small concentric ribs and numerous fine radial striæ.

Measurements :

	(1)	(2)	(3)	(4)
Length .	7 .	6 .	5·5 .	5 mm.
Height .	5 .	5 .	4·5 .	4·5 ,,

(1) Atherfield Beds, Sevenoaks.
(2) Atherfield Beds, Peasmarsh.
(3, 4) *Perna*-bed, East Shalford.

Affinities.—This species resembles *Astarte formosa* (see p. 112) but is larger, less triangular in outline, with a larger apical angle and fewer ribs. *A. similis*, Goldfuss,[1] belongs to the same group, but is more rounded in outline, and has more numerous ribs than *A. subcostata.*

Forbes states that English examples of this species were identified by d'Orbigny as *A. numismalis*, d'Orbigny,[2] but adds that they resemble much more nearly d'Orbigny's *A. striato-costata.* They differ from the figures of *A. numismalis* given by d'Orbigny in being less triangular, and in having the posterior end more truncated; also the ribs are less numerous but more prominent, and form a larger angle with the postero-dorsal margin. English examples were also seen by Pictet and Renevier, and were identified by them with *Astarte laticosta*, Deshayes (= *striato-costata* and *subcostata*, d'Orbigny). The specimen figured by d'Orbigny is more elongate than most of the English examples, but agrees in this respect with some found in the Atherfield Clay of Sevenoaks. The specimens figured by Leymerie are much larger than the English examples, and the ribs are more numerous and less prominent. Some of the differences seen in the figures of the authors quoted in the synonymy are probably due to the differences in the age of the specimens. In the young specimens the posterior end is more rounded, in old specimens it is more truncated.

Remarks.—Specimens which occur in the Crackers of Atherfield (Plate XV, figs. 1, 2) differ slightly from those described above, but probably constitute only a local variety; the valves are not quite so convex, the ribs are rather more numerous and

[1] For figures and references see Holzapfel, 'Die Mollusk. Aachen. Kreide' (Palæontographica, vol. xxxv, 1889), p. 194, pl. xix, figs. 11—15. *A. similis* was referred to the genus *Gouldia* by Stoliczka: Holzapfel discusses this subject, and I am in agreement with his conclusions.

[2] 'Pal. Franç. Terr. Crét.,' vol. iii (1844), p. 63, pl. cclxii, figs. 4—6; Pictet and Campiche, 'Terr. Crét. Ste. Croix' (1866), p. 309.

less prominent, and the posterior end of the shell is rather more pointed. This form resembles *A. angulata*, Guéranger.[1]

Types.—The types of *A. laticosta* came from the Neocomian of Chaource and Jully (Aube). D'Orbigny's specimens of *A. striato-costata* were obtained from the Neocomian of Marolles (Aube), Attancourt (Haute-Marne), and Saint-Sauveur (Yonne). The specimens described by Forbes are in the Museum of the Geological Society (No. 2181).

Distribution.—Atherfield Beds of Peasmarsh and Sevenoaks. *Perna*-bed of East Shalford, and probably Atherfield. Recorded by Topley from the Atherfield Beds of Haslemere, and the Hythe Beds of Lympne.

ASTARTE, sp. Plate XV, figs. 3, 4.

Some specimens from the Folkestone Beds of Folkestone are very similar to *A. subcostata*, d'Orbigny, but are larger, less elongate, and have a smaller apical angle.

ASTARTE OMALIOIDES, sp. nov. [ex *Gardner* MS.]. Plate XV, figs. 5–7.

Description.—Shell small, triangular or sub-quadrate, compressed, slightly inequilateral, height and length nearly equal. Dorsal half of valves pointed. Antero-dorsal margin slightly concave; postero-dorsal margin rather longer and nearly straight, the remaining margin forming a regular curve. Umbones pointed. Margins of valves finely crenulate.

Ornamentation consists of a few (usually 6 or 7) prominent, sharp, concentric ribs, with steep dorsal slopes and more gentle ventral slopes. Interspaces very broad. The ribs become more distant from one another in passing from the umbo to the ventral margin. A few very faint concentric ribs are sometimes present also.

Measurements :

	(1)	(2)	(3)
Length .	5·0 .	4·25 .	4·0 mm.
Height .	4·75 .	4·25 .	4·0 ,,

(1—3) Gault, Folkestone.

Affinities.—This species is closely allied to *A. subcostata* (see p. 109), but is relatively shorter and less convex, and has a smaller apical angle and rather fewer ribs.

[1] 'Album Paléont. de la Sarthe' (1867), p. 13, pl. xvi, fig. 5.

Remarks.—Since the name *Omalioides* has been used in stratigraphical lists,[1] it seems desirable to retain it, although its construction is not in accordance with the recommendations of the International Congress of Zoology.

Distribution.—Gault (zones vii, x, and xi) of Folkestone.

ASTARTE FORMOSA, *Sowerby*, 1836. Plate XV, figs. 8–13.

1836. ASTARTE FORMOSA, *J. de C. Sowerby*. Trans. Geol. Soc., ser. 2, vol. iv., pp. 239, 341, pl. xvi, fig. 16.
1842. — — *F. Römer*. De Astartarum Genere, p. 21.
1850. — — *A. d'Orbigny*. Prodr. de Pal., vol. ii, p. 160.
1854. — — *J. Morris*. Cat. Brit. Foss., ed. 2, p. 186.
1871. — — *F. Stoliczka*. Palæont. Indica, Cret. Fauna S. India, vol. iii, p. 285 (? *Gouldia*).

Non 1842. — — *H. B. Geinitz*. Char. d. Schicht. u. Petref. des sächs.-böhm. Kreidegeb., pt. 3, p. 76, pl. xxi, fig. 19 (see *Geinitz*, Elbthalgeb. i, p. 227).
— 1844. — — *A. d'Orbigny*. Pal. Franç. Terr. Crét., vol. iii, p. 65, pl. cclxii, figs. 10—12 (*A. subformosa*, d'Orb., 1850).

Description.—Shell small, rather convex, sub-triangular, moderately inequilateral. Antero-dorsal margin slightly concave. Anterior and ventral margins forming a regular curve. Posterior margin less curved, often truncated, and forming an obtuse angle with the long and slightly convex postero-dorsal margin. Umbones pointed. Lunule large, ovate, depressed, smooth, with a sharp border. Escutcheon long, lanceolate, depressed, smooth, with a sharp border. Margins of valves smooth.

Ornamentation consists of strong concentric ribs with sharp summits, separated by broad concave interspaces. The ribs end abruptly at the margins of the lunule and escutcheon. On the ribs and interspaces fine concentric ridges may be seen.

Measurements :

	(1)	(2)	(3)	(4)	(5)	(6)
Length	5·0	4·75	4·5	4·0	3·25	3·0 mm.
Height	4·5	4·5	4·0	3·75	3·0	2·5 ,,

(1—6) Blackdown.

Affinities.—*A. formosa* is smaller and has more numerous ribs than *A. subformosa*,

[1] Price, 'The Gault' (1879), p. 58; Jukes-Browne, 'Cret. Rocks of Britain,' vol. i (1900), p. 465.

d'Orbigny.[1] *A. acuta*, Reuss,[2] is another allied form, but possesses fewer ribs than *A. formosa*. See also *A. subcostata* (p. 109).

Type.—From Blackdown, in the Bristol Museum.

Distribution.—Upper Greensand (zone of *Schlœnbachia rostrata*) of Blackdown and Haldon.

Astarte impolita, *Sowerby*, 1836. Plate XV, fig. 14.

1836. Astarte impolita, *J. de C. Sowerby.* Trans. Geol. Soc., ser. 2, vol. iv, pp. 239, 341, pl. xvi, fig. 18.
1854. — — *J. Morris.* Cat. Brit. Foss., ed. 2, p. 187.

The only example of this which I have seen is the type specimen from the Greensand of Blackdown.[3] Both valves are present, but the parts near the umbo and lunule are missing. The specimen is in the Bristol Museum.

Sub-genus—Eriphyla, *W. M. Gabb*, 1864.

('Geol. Surv. California, Palæont.,' vol. i, p. 180. Stoliczka, 'Palæont. Indica, Cret. Fauna, S. India,' vol. iii, 1870, p. 156.)

Astarte (Eriphyla) obovata, *Sowerby*, 1822. Plate XV, figs. 15–18. Plate XVI, figs. 1–3.

1822. Astarte obovata, *J. de C. Sowerby.* Min. Conch., vol. iv, p. 73, pl. ccclііі.
1842. — — *F. Römer.* De Astartarum Genere, p. 22.
1845. — — *E. Forbes.* Quart. Journ. Geol. Soc., vol. i, p. 241.
1850. Corbis obovata, *A. d'Orbigny.* Prodr. de Pal., vol. ii, p. 78.
1852. Astarte Brunneri, *F. J. Pictet and W. Roux.* Moll. Foss. Grès verts de Genève, p. 435, pl. xxxii, fig. 3.
— — gurgitis, *Pictet and Roux.* Ibid., p. 436, pl. xxxiii, fig. 1.
1854. — obovata, *J. Morris.* Cat. Brit. Foss., ed. 2, p. 187.
1857. — — *F. J. Pictet and E. Renevier.* Foss. Terr. Aptien (Matér. Pal. Suisse, ser. 1), p. 86, pl. xi, fig. 1.

[1] 'Prodr. de Pal.,' vol. ii (1850), p. 77.

[2] 'Die Verstein. der böhm. Kreideformat.,' pt. 2 (1846), p. 3, pl. xxxiii, fig. 17; pl. xxxvii, fig. 14; Nötling, 'Die Fauna d. baltisch. Cenoman.' (Palæont. Abhandl., vol. ii, 1885), p. 28, pl. v, fig. 1. According to Nötling, *A. plauensis*, Geinitz, is a synonym of *A. acuta*.

[3] *Astarte multistriata* was also described by J. de C. Sowerby from Blackdown, but I have not seen any example of it. See 'Trans. Geol. Soc.,' ser. 2, vol. iv, pp. 240, 341, pl. xvi, fig. 17; Morris, 'Cat. Brit. Foss.,' ed. 2 (1854), p. 187.

? 1865. Astarte obovata, *H. Coquand.* Mon. Aptien de l'Espagne, p. 122, pl. xiii, figs. 3, 4.
1866. — — *F. J. Pictet and G. Campiche.* Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 4), p. 312.
1871. — — (Eryphyla), *F. Stoliczka.* Palæont. Indica, Cret. Fauna, S. India, vol. iii, p. 285.
1892. — — *O. Behrendsen.* Zeitschr. d. deutsch. geol. Gesellsch., vol. xliv, p. 22.

Description.—Shell large, oval, transverse, moderately inflated, very inequilateral. Anterior margin rounded, concave in front of the umbo. Behind the umbo the dorsal margin has a gentle and regular curve. Posterior margin rounded or sub-truncate. Umbones prominent, curving forward. Lunule deep. Escutcheon narrow, deep.

Ornamentation consists of numerous, strong, close, somewhat irregular concentric ribs, on which fine, concentric, linear ribs occur.

Measurements:

	(1)	(2)	(3)	(4)	(5)	(6)
Length . .	75 .	74 .	73 .	70 .	72 .	71 mm.
Height . .	62 .	58 .	60 .	59 .	63 .	59 ,,

(1–4) *Perna*-bed, Atherfield.
(5, 6) *Perna*-bed, Sandown.

Affinities.—*Astarte Beaumonti*, Leymerie,[1] and *A. transversa*, Leymerie,[2] are closely allied to *A. obovata*, and were regarded by Forbes as merely varieties of the latter. Pictet and Renevier (1857) were inclined to regard the differences as not of specific importance. Pictet and Campiche (1866), however, kept the three forms distinct, but were uncertain whether they should be regarded as species or varieties. They state that in *A. Beaumonti* the margin is smooth, whilst in *A. obovata* and *A. transversa* it is crenulated. In the first two forms the posterior margin is more rounded, but in the last it is more truncate. It is very doubtful whether the crenulation of the margin is a feature of specific importance in *Astarte*; indeed, one writer[3] thinks that it is a characteristic of sex. Whether the other differences are of specific value can be determined only by the comparison of a number of examples of *A. Beaumonti* and *A. transversa* with specimens of *A. obovata.*

[1] 'Mem. Soc. géol. de France,' vol. v (1842), pp. 4, 24, pl. iv. fig. 1. D'Orbigny, 'Terr. Crét.,' vol. iii (1844), p. 60, pl. cclx. Pictet and Campiche, 'Terr. Crét. Ste. Croix' (1866), p. 300, pl. cxxiv, fig. 1. Wollemann, 'Biv. u. Gastrop. d. deutsch. u. holländ. Neocoms' (1900), p. 95.

[2] *Op. cit.* (1842), pp. 4, 24, pl. v, fig. 5. D'Orbigny, *op. cit.*, p. 61, pl. cclxi. Pictet and Campiche, *op. cit.*, p. 301, pl. cxxiv, fig. 2. De Loriol, 'Anim. Invert. Foss. Mt. Salève' (1861), p. 68, pl. viii, fig. 9.

[3] A. Ostroumoff, 'Zool. Anzeiger,' vol. xxiii (1900), p. 499.

The shallow pallial sinus shown in internal casts, and the characters of the hinge seem to warrant the reference of this species to the sub-genus *Eriphyla*.

Remarks.—Some of the specimens found in the Isle of Wight have the posterior end rounded, but in the larger number it is more or less distinctly truncated. The former approach *A. Beaumonti*; the latter resemble *A. transversa*. I have not seen any examples from the Isle of Wight which show the internal margin of the valve sufficiently clearly to determine whether it is crenulate or not, but in an internal cast from the Hythe Beds of Hythe (Museum of the Geological Society, No. 2187) the crenulation is distinct.

The specimens of *A. obovata* show a fairly large amount of variation. In some the anterior part of the valve is quite short, as in Leymerie's figure of *A. transversa*; in others it is much longer. The relative height and length, the amount of rounding or truncation of the posterior margin, and the coarseness of the ornamentation also vary.

The specimens from the Hythe Beds of Hythe are very poorly preserved. Those from the Greensand of Blackdown and Haldon appear, so far as one can tell from the few perfect specimens available, to be rather shorter than most of the Lower Greensand examples.

Types.—The type cannot be found; it came from the *Perna*-bed of Sandown.

Distribution.—Lower Greensand (*Perna*-bed) of Atherfield and Sandown. Recorded by Topley from the Atherfield Beds of Peasemarsh and Shalford, and from the Hythe Beds of Hythe and Lympne.

Upper Greensand (zone of *Schlœnbachia rostrata*) of Blackdown and Haldon.

Astarte (Eriphyla) lævis (*Phillips*), 1829. Plate XVI, figs. 5–7. Plate XVII, fig. 1.

1829. Crassina lævis, *J. Phillips*. Geol. Yorks., p. 122, pl. ii, fig. 19 (? fig. 18).
1835. Astarte lævis, *Phillips*. Ibid., ed. 2, pt. 1, p. 158 (ed. 3, 1879, p. 252).
1854. — — *J. Morris*. Cat. Brit. Foss., ed. 2, p. 187.

Description.—Shell large, thick, convex, ovate, usually considerably inequilateral; height and length nearly equal, or the height may be rather greater than the length or *vice versâ*. Antero-dorsal margin rather long and slightly concave; postero-dorsal margin very long and moderately convex. Anterior and ventral margins well rounded. Posterior extremity rounded or sometimes subangular. Umbones large. Lunule large, ovate, deep, nearly smooth, with a sharp border. Escutcheon narrow, deep.

Ornamentation consists of numerous, rather strong, narrow, concentric ribs which are somewhat irregular.

Hinge-plate broad, triangular. In the left valve two strong cardinal teeth and one lateral at the margin of the lunule. Teeth of right valve not seen. Margins of valves strongly crenulate.

Measurements :

	(1)	(2)	(3)	(4)
Length .	57 .	51 .	51 .	44 mm.
Height .	59 .	56 .	47 .	39 „

(1–4) Claxby Ironstone, Benniworth Haven.

Affinities.—This species is allied to *Astarte Sæmanni*, de Loriol,[1] of which good specimens are found in the Portland Sands of Swindon. In some cases the resemblance is very close, but generally the umbones are more prominent, the antero-dorsal margin relatively longer, and the valves more convex in *A. lævis* than in *A. Sæmanni.*

A. Buchi, Römer,[2] is apparently allied to *A. lævis*, but is distinguished by the greater anterior curvature of its umbones. *A. gigantea*, Leymerie,[3] is less inequilateral and more elongate than *A. lævis.*

Remarks.—Most of the examples of this species have been obtained from the Claxby Ironstone. Only two have been seen from the Speeton Clay, one being in the Leckenby Collection (Sedgwick Museum), the other in Mr. Lamplugh's Collection; these appear to agree with the larger example of *Astarte lævis* figured by Phillips (fig. 19).

Types.—The type, from the Speeton Clay, appears to be missing.

Distribution.—Claxby Ironstone (zone of *Belemnites lateralis*) of Benniworth Haven. Speeton Clay of Speeton.

ASTARTE (ERIPHYLA) STRIATA, Sowerby, 1826. Plate XVII, figs. 2–7.

1826. ASTARTE STRIATA, *J. de C. Sowerby.* Min. Conch., vol. vi., p. 35, pl. dxx, fig. 1.
1836. — CONCINNA, *J. de C. Sowerby.* Trans. Geol. Soc., ser. 2, vol. iv, pp. 239, 341, pl. xvi, fig. 15.
1842. — — *F. Römer.* De Astartarum Genere, p. 21.

[1] De Loriol and Pellat, 'Portlandien de Boulogne-sur-mer' (1866), p. 68, pl. vi, fig. 9. E. G. Skeat and V. Madsen, 'Jur. Neoc. and Gault Boulders in Denmark' (1898), p. 123, pl. iii, fig. 2.

[2] 'De Astartarum Genere' (1842), p. 20, fig. 4. Pictet and Renevier, 'Foss. Terr. Aptien' (1856), p. 85, pl. x, fig. 1.

[3] For references see Pictet and Campiche, 'Terr. Crét. Ste. Croix' (1866), p. 298.

1850. Astarte striata, *A. d'Orbigny.* Prodr. de Pal., vol. ii, p. 160 (*partim*).
— — concinna, *d'Orbigny.* Ibid., p. 160.
1854. — striata, *J. Morris.* Cat. Brit. Foss., ed. 2, p. 187.
— — concinna, *Morris.* Ibid., p. 186.
1866. — striata, *F. J. Pictet and G. Campiche.* Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 4), p. 230.
1871. — — (Eryphila), *F. Stoliczka.* Palæont. Indica, Cret. Fauna S. India, vol. iii, p. 285.
— — concinna (Eriphyla), *Stoliczka.* Ibid., p. 285.
? 1873. Eriphyla striata, *H. B. Geinitz.* Das Elbthalgeb. in Sachsen (Palæontographica, vol. xx, pt. 1), p. 228, pl. li, figs. 1–3.

Description.—Shell with rounded outline, sometimes nearly orbicular, usually only moderately inequilateral, moderately convex. Length usually a little greater than height, but occasionally less. The margin in front of the umbo is concave for a short distance; behind the umbo it is convex; the anterior, the ventral, and posterior margins form a more or less regular curve. Umbones rather small, placed a little in front of the median line. Lunule small, deep, with a sharp edge. Escutcheon narrow.

Ornamentation consists of numerous small concentric ribs, which are slightly irregular and are separated by linear grooves; at intervals somewhat deeper grooves may occur.

Hinge-plate wide. Two cardinal teeth in each valve, and one lateral tooth next the lunule in the left valve. Adductor impressions deep, the anterior somewhat elongated. Pallial sinus shallow, rounded. Margins of valves smooth.

Measurements:

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	
Length	46	45	44	42	39	37	35	28	mm.
Height	45	42	41	43	37	34	34·5	27·5	,,

(1–8) Blackdown.

Affinities.—This species is closely allied to *A.* (*Eriphyla*) *lenticularis* (Goldfuss),[1] but the outline of the valve is less regularly orbicular.

Astarte Konincki, d'Archiac,[2] from the Tourtia of Tournay, was regarded by d'Orbigny, Pictet and Campiche, Stoliczka, and Geinitz as a synonym of *A. striata*. I have not seen any example of the former, but it appears to differ from *A. striata* in having less prominent umbones, more inflated valves, a more regularly orbicular

[1] 'Petref. Germ.,' vol. ii (1840), p. 228, pl. cxlvi, fig. 16. Holzapfel, 'Zeitschr. d. deutsch. geol. Gesellsch.,' vol. xxxvi (1884), p. 458, pl. vi, figs. 1, 2, and 'Palæontographica,' vol. xxxv (1889), p. 195, pl. xiv, figs. 5–7.

[2] 'Mém. Soc. géol. de France,' ser 2, vol. ii (1847), p. 302, pl. xiv, fig. 4.

outline, and apparently also fewer ribs. Two imperfect specimens from the Cenomanian (Bed 11) of Dunscombe were referred to *A. Konincki* by the late C. J. A. Meÿer, but they are less convex than that species and seem to agree more nearly with *A. striata.*

Astarte concinna, Sowerby, was regarded by Stoliczka as probably identical with *A. striata.* It is known by the type specimen only, and agrees with *A. striata*, except that it is rather higher and more inequilateral. I believe that it is merely an individual variation of *A. striata.*

Types.—From Blackdown, in the British Museum. The type of *A. concinna* is from Blackdown and is now in the Bristol Museum.

Distribution.—Upper Greensand (zone of *Schlœnbachia rostrata*) of Blackdown.

Genus—Opis, *M. J. L. Defrance*, 1825.

('Dict. Sci. nat.' vol. xxxvi, p. 219.)

Opis neocomiensis, *d'Orbigny*, 1844. Plate XVII, figs. 8–12.

1842. Opis *A. Leymerie.* Mém. Soc. géol. de France, ser. 2, vol. v, p. 25, pl. vii, fig. 4.
1844. — neocomiensis, *A. d'Orbigny.* Pal. Franç. Terr. Crét., vol. iii, p. 51, pl. ccliii, figs. 1—5.
1850. — — *d'Orbigny.* Prodr. de Pal., vol. ii, p. 76.
1855. — — *G. Cotteau.* Moll. Foss. de l'Yonne, p. 67.
1857. — — *F. J. Pictet and E. Renevier.* Foss. Terr. Aptien (Matér. Pal. Suisse, ser. 1), p. 83, pl. ix, fig. 7.
1861. — Desori, *P. de Loriol.* Anim. Invert. Foss. Mt. Salève, p. 66, pl. viii, figs. 4—7.
1866. — neocomiensis, *F. J. Pictet and G. Campiche.* Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 4), p. 324, pl. cxxv, figs. 3, 4.
1868. — — *P. de Loriol.* Valangien d'Arzier, p. 31.
? 1871. — — *W. A. Ooster.* Protozoe Helvet., vol. ii, p. 101, pl. xv, fig. 17.
1883. — — *W. Keeping.* Foss. etc., Neoc. Upware and Brickhill, p. 121, pl. vi, fig. 8.
1900. — — *A. Wollemann.* Die Biv. u. Gastrop. d. deutsch. u. holländ. Neocoms (Abhandl. d. k. preussisch. geol. Land., N. F., pt. 31), p. 102.

Description.—Shell trigonal or sub-quadrilateral, much higher than long, inequilateral, greatly inflated, but with flattened sides. Anterior margin rounded.

Posterior margin truncated, slightly concave, forming an angle with the gently curved ventral margin and also with the postero-dorsal margin. Umbones prominent, slender, greatly incurved, almost touching in the young, but separated in older specimens. A prominent carina extends from the umbo to the postero-ventral angle, cutting off an area which is divided into two parts by a prominent but rounded carina which ends at the postero-dorsal angle; the outer part only of the area is seen in a side view, and is concave; the inner part is depressed, and its dorsal portion is flattened and resembles a lunule. Lunule very large, cordate, flattened.

Ornamentation consists of many small concentric ribs separated by narrow grooves. Behind and in front of the flattened part of the valve this ornamentation becomes less distinct or may disappear altogether. Margin of valve entire.

Measurements :

	(1)	(2)	(3)	(4)	(5)
Length	23	22	20	14	14 mm.
Height[1]	35	33	29	20·5	19 ,,
Thickness	26	26	24	16	15 ,,

(1—5) Lower Greensand, Upware.

Affinities.—This species shows some resemblance to *O. Hugardiana*, d'Orbigny,[2] from the Gault.

Remarks.—The shell is relatively higher in large than in small specimens. In all the examples obtained from Upware the shell is preserved. Specimens from Seend are in the Museum of Practical Geology.

Types.—Leymerie's specimen came from the Lower Neocomian of Bernon (Aube). D'Orbigny's specimens were obtained from Saint Sauveur (Yonne), Bernon, and Marolles. The specimen figured by Keeping is in the Sedgwick Museum.

Distribution.—Lower Greensand of Upware and Seend. Internal casts, probably belonging to this species, are found in the Lower Greensand of Coleshill near Faringdon.

Opis haldonensis, sp. nov. Plate XVIII, fig. 1 *a–d*.

Description.—Shell trigonal, higher than long, moderately inequilateral, convex, with flattened sides. Anterior margin slightly convex, passing gradually into the

[1] Measured from the umbo to the postero-ventral angle.

[2] Syn. *O. Sabaudiana*, d'Orbigny, 'Pal. Franç. Terr. Crét.,' vol. iii (1844), p. 53, pl. cclvii, figs. 4—6; Pictet and Roux, 'Moll. Foss. Grès verts de Genève' (1852), pp. 432—434, pl. xxxii, fig. 1.

slightly curved ventral margin. Posterior margin somewhat oblique, slightly concave. Postero-ventral angle rounded. Umbones high, prominent, not much incurved. A prominent, rounded carina extends from the umbo to the postero-ventral angle, and cuts off a posterior area which is divided into two parts by a strong, rounded carina ending at the postero-dorsal angle. The part of the area between the carinæ is concave; the part behind the median carina is deeply depressed. Lunule large, very deep, flattened. Surface of shell apparently smooth. Length, 43 mm. Height, 58 mm.

Affinities.—It is possible that this species may be related to *O. Galliennei*, d'Orbigny,[1] which seems to be known by casts only, but the height of the shell appears to be relatively less. *O. Galliennei* has been identified by some authors with *O. bicornis* (Geinitz)[2] from the Cenomanian of Plauen. The latter differs from the species described above in possessing strong concentric ribs and in the absence of a carina between the umbo and the postero-ventral angle.

Remarks.—The only undoubted example of this species which I have seen is a right valve collected by the late W. Vicary, and now in the British Museum. The surface of the shell is not well preserved, but appears to have been nearly smooth.

An imperfect specimen of a large *Opis* (length about 63 mm.) from the Chloritic Marl of Eggerdon Hill (Dorset) is in the Sedgwick Museum, Cambridge, and may belong to this species.

Distribution.—Upper Greensand (zone of *Schlœnbachia rostrata*) of Haldon.

OPIS, sp. Pl. XVII, figs. 13 *a–c*, 14 *a–c*.

Description.—Shell small, sub-triangular, rather oblique; greatest convexity along the carina. Anterior margin rounded; posterior margin slightly convex. Umbones prominent, sharp, considerably curved anteriorly. Carina sharp, prominent, cutting off a steeply sloping posterior area, which is not divided by a median carina. Sides of shell flattened, sloping slightly in front of the carina, and passing gradually into the anterior part of the shell. Lunule very deep, with a sharp border.

Ornamentation consists of regular, concentric ribs. Posterior area nearly smooth.

[1] 'Pal. Franç. Terr. Crét.,' vol. iii (1844), pl. cclvii*bis*, fig. 5 (not described in the text); Guéranger, 'Album Paléont. de la Sarthe' (1867), p. 17, pl. xxii, fig. 13.

[2] "Das Elbthalgeb. in Sachsen" ('Palæontographica,' vol. xx, pt. 1, 1873), p. 227, pl. l, figs. 1—3. Internal casts of *Opis* from the base of the Chalk at Maiden Newton and Chard have been recorded as *O. bicornis?* (Gein.) by Jukes-Browne, 'Cret. Rocks of Britain,' vol. ii (1903), pp. 113, 122. Two of the specimens on which the determination was based are in the Oxford Museum.

Measurements:

	(1)		(2)
Length . . .	8	.	7·5 mm.
Umbo to postero-ventral angle .	12	.	11·0 ,,

(1, 2) Haldon.

Affinities.—This species may perhaps be related to *O. cenomanensis*, Guéranger,[1] but the figure of the latter is too indistinct for recognition.

Remarks.—There are four examples of this species in the Vicary Collection, British Museum.

Distribution.—Upper Greensand (zone of *Schlœnbachia rostrata*) of Haldon.

Family—CARDITIDÆ, *Gill.*

Genus—Cardita, *J. G. Bruguière*, 1792.[2]

('Encyc. méth., Vers,' vol. i, p. 401.)

Cardita? fenestrata (*Forbes*), 1845. Plate XVIII, figs. 2–4.

1845.	Venus? fenestrata,	*E. Forbes.*	Quart. Journ. Geol. Soc., vol. i, p. 240, pl. ii, fig. 6.
1850.	Cardita —	*A. d'Orbigny.*	Prodr. de Pal., vol. ii, p. 77.
1854.	Venus —	*J. Morris.*	Cat. Brit. Foss., ed. 2, p. 230.
1856.	Cardita —	*F. J. Pictet and E. Renevier.*	Foss. Terr. Aptien (Matér. Pal. Suisse, ser. 1), p. 82, pl. ix, fig. 4.
1866.	— —	*F. J. Pictet and G. Campiche.*	Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 4), p. 333.
1871.	— —	*F. Stoliczka.*	Palæont. Indica, Cret. Fauna S. India, vol. iii, p. 287.

Description.—Shell oval or somewhat rhomboidal, much longer than high, very inequilateral, moderately inflated, but with flattened sides. Anterior margin rounded; ventral margin slightly curved or almost straight, and nearly parallel with the dorsal margin; posterior margin obliquely truncated, forming an acute angle

[1] 'Album Paléont. de la Sarthe' (1867), p. 13, pl. xvi, fig. 3.

[2] Owing to the difficulty of distinguishing the fossil forms of *Cardita* from *Venericardia* when, as in the case of nearly all the examples found in the Cretaceous rocks of England, the hinge is unknown, all the species are, for the present, referred to *Cardita*.

with the ventral margin, and an obtuse angle with the dorsal margin. Umbones moderately prominent, curving forwards, bearing a carina which extends to the postero-ventral angle and cuts off a flattened or concave area. Lunule ovate, rather large, nearly smooth. Escutcheon with a sharp edge.

Ornamentation consists of narrow, rounded, radial ribs, separated by broad, flat interspaces, and crossed at rather distant intervals by strong, narrow, concentric, lamellar ribs, which give rise to a scale-like projection where they join the radial ribs. The postero-dorsal area has similar concentric ribs, and a strong radial rib near the dorsal margin, and another near the middle of the area with smaller ribs between.

Measurements :

	(1)	(2)	(3)	(4)	(5)	(6)
Length .	20	19	19	19	18	16 mm.
Height .	14	13	12	11·5	12	11 ,,

(1—6) *Perna*-bed, Atherfield.

Affinities.—*C. fenestrata* appears to be quite distinct from other Cretaceous species of *Cardita*, but shows some resemblance in form to *C. tricarinata*, d'Orbigny,[1] from the Cenomanian of Le Mans. The hinge and interior are unknown, and the generic position of the species is not free from doubt. Stoliczka remarks that '*C. fenestrata* is not unlike a *Venerupis*.'

Type.—From Peasmarsh, in the Museum of the Geological Society, Nos. 2182, 2183.

Distribution.—*Perna*-bed and Atherfield Clay of Atherfield. Atherfield Beds of Peasmarsh and East Shalford.

Cardita upwarensis, sp. nov. Plate XVIII, fig. 5.

1883. Cardita rotundata? *W. Keeping*. Foss., etc. Neoc. Upware and Brickhill, p. 121, pl. vi, fig. 7.

Description.—Shell subtriangular, inflated, height and length nearly equal, inequilateral. Anterior margin rounded, passing gradually into the convex ventral margin. Posterior margin truncated, oblique, not sharply limited from the postero-dorsal margin. Umbones prominent, strongly curved anteriorly, with a rounded

[1] 'Pal. Franç. Terr. Crét.,' vol. iii (1844), p. 95, pl. cclxxxiii *bis*., figs. 5—7; Guéranger, 'Album Paléont. de la Sarthe' (1867), p. 13, pl. xvi, figs. 19, 20.

carina extending to the postero-ventral angle, and cutting off a steeply-sloping postero-dorsal part of the valve. Lunule rather small, cordate, broader than long.

Ornamentation consists of about twenty-five radial ribs on the part of the valve in front of the carina; the ribs are strong and rounded, but are narrower than the interspaces. Both are crossed by regular concentric lamellæ, which become prominent on the ribs. On the postero-dorsal area the ribs are smaller, more numerous, and closer together; two of these ribs are rather stronger than the others, and divide the area into three parts. Length 21 mm.; height 20·5 mm.; thickness 17 mm.

Affinities.—This species was doubtfully referred by W. Keeping to *C. rotundata*, Pictet and Roux, but it differs from that form by its fewer and stronger ribs and more triangular outline (see p. 125).

In form it resembles *C. Dupiniana*, d'Orbigny,[1] but the ribs on the postero-dorsal area are smaller and more numerous. In this respect, and in its shorter and less quadrate outline, it differs from *C. neocomiensis*, d'Orbigny.[2]

Remarks.—I have seen only three examples of this species, two of which are in the Sedgwick Museum, and one is in the collection of Mr. J. F. Walker.

Distribution.—Lower Greensand of Upware and Potton.

Cardita, sp. Plate XVIII, fig. 6.

A specimen consisting of the united valves from which the ventral parts are missing was obtained by Leckenby from the *Perna*-bed of Atherfield, and is now in the Sedgwick Museum. It shows some resemblance to *C. upwarensis* (see above), but is more elongate and more distinctly carinate.

Cardita, sp.

Two specimens of *Cardita* from the Hythe Beds of Maidstone are in the Museum of the Geological Society. They were examined by Edward Forbes,[3] who identified one with *C. neocomiensis*, d'Orbigny, and the other with *C. quadrata*, d'Orbigny. The specimens are similar in form to those species, but their state of preservation is too imperfect for satisfactory determination.

[1] 'Pal. Franç. Terr. Crét.,' vol. iii (1844), p. 88, pl. cclxviii, figs. 6—10; Pictet and Campiche, 'Foss. Terr. Crét. Ste. Croix' ('Matér. Pal. Suisse,' ser. 4, 1866), p. 334, pl. cxxvi, figs. 4, 5.

[2] D'Orbigny, *op. cit.*, p. 85, pl. cclxvii, figs. 1—6.

[3] 'Quart. Journ. Geol. Soc.,' vol. i (1845), p. 242.

Cardita tenuicosta (*Sowerby*), 1836. Plate XVIII, figs. 7–14.

1836. Venericardia tenuicosta. *J. de C. Sowerby.* Trans. Geol. Soc., ser. 2, vol. iv, pp. 114, 259, 356, pl. xi, fig. 7*.
1838. Cardium tetragonum, *H. Michelin.* Mém. Soc. géol. de France, vol. iii, p. 102, pl. xii, fig. 3.
1842. Venericardia tenuicosta, *A. Leymerie.* Mém. Soc. géol. de France, ser. 2, vol. v, p. 25, pl. iii, fig. 9.
1844. Cardita tenuicosta, *A. d'Orbigny.* Pal. Franç. Terr. Crét., vol. iii, p. 87, pl. cclxviii, figs. 1—5.
1846. Venericardia tenuicosta, *A. Leymerie.* Statist. géol. et min. de l'Aube, pl. v, fig. 7.
1850. Cardita — *d'Orbigny.* Prodr. de Pal., vol. ii, p. 137.
1854. — — *J. Morris.* Cat. Brit. Foss., ed. 2, p. 191.
1855. — — *G. Cotteau.* Moll. Foss. de l'Yonne, p. 72.
1866. — — *F. J. Pictet and G. Campiche.* Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 4), p. 335, pl. cxxvi, figs. 6—9.
1871. — — *F. Stoliczka.* Palæont. Indica, Cret. Fauna S. India, vol. iii, p. 287.

Non 1842. Venericardia — *H. B. Geinitz.* Char. d. Schicht. u. Petref. des sächs.-böhm. Kreidegeb., pt. 3, p. 76, pl. xx, fig. 9 (*C. Geinitzi*, d'Orbigny).
— 1846. Cardita (Venericardia) tenuicosta, *A. E. Reuss.* Die Verstein. der böhm. Kreideformat., pt. 2, p. 4, pl. xxxiii, fig. 16 (*C. corrugata*, Reuss).
— 1873. Cardita tenuicosta, *H. B. Geinitz.* Das Elbthalgeb. in Sachsen (Palæontographica, vol. xx, pt. 2), p. 60, pl. xvii, figs. 11—13.
— 1885. — (Venericardia) tenuicosta, *F. Nötling.* Die Fauna d. baltisch. Cenoman. (Palæont. Abhandl., vol. ii), p. 29, pl. v, fig. 4.
— 1889. — tenuicosta, *A. Fritsch.* Stud. im Gebiete der böhm. Kreideformat., iv. Teplitz. Schicht., p. 78, fig. 62.
— 1893. — — *Fritsch.* *Ibid* v. Priesener Schicht., p. 91.
? — 1900. — — *A. Wollemann.* Die Biv. u. Gastrop. d. deutsch. u. holländ. Neocoms (Abhandl. d. k. preussisch. geol. Land., N. F., pt. 31), p. 94, pl. iv, fig. 9.

Description.—Shell more or less sub-quadrate, rounded, moderately convex, with the postero-dorsal portion compressed; length greater than height; moderately inequilateral. Postero-dorsal margin only slightly curved; posterior margin more or less truncated, passing by a regular curve into the ventral margin, which is only slightly convex and nearly parallel with the postero-dorsal margin. Anterior margin rounded. Antero-dorsal margin concave. Umbones curved anteriorly. Lunule ovate, nearly smooth. Escutcheon lanceolate, with a sharp edge.

Ornamentation consists of 47 to 57 rounded radial ribs, which are separated by furrows of greater breadth than themselves; near the postero-dorsal margin these ribs are rather closer together than elsewhere. In some cases the postero-dorsal part of the valve is divided into two parts by two ribs, which are more prominent than the others. At regular intervals concentric lamellæ occur and form marked projections where they cross the ribs. Near the umbo these lamellæ are more widely separated, and near the margin, especially in large specimens, they are closer together than elsewhere. Sometimes faintly marked concentric ridges may be seen on the ribs between the lamellæ. Margins of valves crenulate.

Measurements:

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	
Length .	30	27	25	24	24	23·5	23	23	22	22	20	16	15	15	mm.
Height .	26·5	23	22	22	20	21	21	19·5	20	19	17	14·5	14	13	,,

(1—14) Gault, Folkestone.

Affinities.—This species has more numerous ribs and is less inflated than *C. neocomiensis*, d'Orbigny and *C. Dupiniana*, d'Orbigny.[1] It possesses about the same number of ribs as *C. Constanti*, d'Orbigny,[2] but is less elongate and less inflated. *C. rotundata*, Pictet and Roux,[3] differs from *C. tenuicosta* in being more inflated, and can be regarded as only an individual variation. Some examples found at Folkestone, which in other respects agree with *C. tenuicosta*, are as much inflated as the type of *C. rotundata*. *C. clathrata*, Buvignier,[4] is a small form, but has the concentric laminæ more widely separated than in even the young of *C. tenuicosta*. *C. argonnensis*, Buvignier,[5] is more compressed and has more slender ribs than *C. tenuicosta*. *C. cenomanensis*, d'Orbigny,[6] is distinguished from *C. tenuicosta* by its broader ribs and more closely placed concentric lamellæ.

C. tenuicosta has narrower ribs and broader furrows than the forms from the Chalk

[1] For references to figures of these species see p. 123, footnotes 1, 2.

[2] 'Pal. Franç. Terr. Crét.,' vol. iii (1844), p. 89, pl. cclxix, figs. 1—5; Pictet and Campiche, 'Foss Terr. Crét. Ste. Croix' ('Matér. Pal. Suisse,' ser. 4, 1866), p. 337, pl. cxxvi, fig. 10.

[3] 'Moll. Foss. Grès verts de Genève' (1852), p. 443, pl. xxxiii, fig. 6.

[4] 'Statist. géol., etc., de la Meuse,' Atlas (1852), p. 19, pl. xv, figs. 16, 17.

[5] Ibid., p. 19, pl. xxxii, figs. 1—3.

[6] D'Orbigny, *op. cit.*, p. 94, pl. cclxxxiii *bis.*, figs. 1—4.

of Saxony and Bohemia which have been referred to that species by Geinitz and by Reuss. *C. tenuicosta* of Reuss is the type of *C.* (*Venericardia*) *bohemica*, Griepenkerl.[1]

Remarks.—Numerous specimens of *C. tenuicosta* from Folkestone have been examined, and they are found to show a considerable amount of variation in convexity and in relative height and length.

Type.—The type came from the Gault of Folkestone, but cannot now be found.

Distribution.—Gault (zones i, v, vii, viii, ix, xi) of Folkestone. Recorded by Jukes-Browne from the Cambridge Greensand, and by Barrois from the Upper Greensand (zone of *Schlœnbachia rostrata*) of the Isle of Wight.

Cardita Cottaldina, *d'Orbigny*, 1844. Plate XVIII, figs. 15, 16.

1844.	Cardita Cottaldina,	*A. d'Orbigny.*	Pal. Franç. Terr. Crét., vol. iii, p. 91, pl. cclxix, figs. 6—8.
1871.	— —	*F. Stoliczka.*	Palæont. Indica, Cret. Fauna S. India, vol. iii, p. 287.
? 1895.	— *cf.* Cottaldina,	*E. Tiessen.*	Zeitschr. der deutsch. geol. Gesellsch., vol. xlvii, p. 485.

Remarks.—Examples of a species of *Cardita*, which is not uncommon in the Chloritic Marl of Dorset, appear to belong to *C. Cottaldina*, but their state of preservation is very unsatisfactory. Most of the specimens are internal casts, and in cases where parts of the shell are present the surface is very imperfect, so that the characters of the ornamentation cannot be clearly distinguished. M. Raoul Fortin informs me that the preservation is equally unsatisfactory in the Cenomanian of Rouen, from whence d'Orbigny's specimens were obtained.

The shell is quadrate in outline, very convex, carinate, and somewhat longer than high. The ornamentation appears to consist of about 40 ribs, separated by interspaces of great width.

C. Cottaldina may be distinguished from *C. tenuicosta* (p. 124) by its fewer ribs, by the length and height being more nearly equal, and by the greater convexity of the valves.

Measurements :

	(1)	(2)	(3)
Length . .	21 .	20 .	16·5 mm.
Height . .	19 .	18 .	14 ,,
Thickness .	16 .	15·5 .	12 ,,

(1—3) Chloritic Marl. (1) Chaldon, (2) Chard, (3) Balcombe.

[1] 'Palæont. Abhandl.,' vol. iv (1889), p. 58.

Distribution.—Chloritic Marl of Balcombe, Cerne, Chaldon, Chalmington, Chard, Maiden Bradley, and Maiden Newton. Recorded by Jukes-Browne from the Chloritic Marl and the zone of *Schlœnbachia varians* of the Isle of Wight.

CARDITA, sp.

Specimens of *Cardita* from which the shell has disappeared, but showing traces of the ribs, are found in the Chalk Marl of Ventnor, Folkestone, etc. These are too imperfect for specific determination. A specimen from Ringmer was figured by Sowerby,[1] and was subsequently regarded by d'Orbigny[2] as an example of his *C. dubia.*

Somewhat similar specimens also occur in the Upper Greensand of Devizes.

CARDITA CANCELLATA, *Woods*, 1897. Plate XVIII, figs. 17, 18.

1897. CARDITA CANCELLATA, *H. Woods.* Quart. Journ. Geol. Soc., vol. liii, p. 390 pl. xxviii, figs. 2—5.

Description.—Shell oval, slightly inequilateral, inflated, postero-dorsal part compressed, faintly carinate; length rather greater than height; margins rounded. Umbones moderately prominent, curved anteriorly.

Ornamentation consists of a large number of radial ribs separated by narrow furrows, and crossed by numerous concentric ribs, giving a nodular appearance at the points of intersection. The concentric ribs are more distinct on the anterior part and the radial ribs more distinct on the median and posterior parts of the shell. Margin of valves finely crenulate.

Measurements :

	(1)	(2)	(3)
Length .	18 .	16 .	13 mm.
Height .	16 .	14·5 .	12 ,,

(1—3) Chalk Rock, Cuckhamsley.

Affinities.—This species is more inflated and more rounded than *C. tenuicosta* (p. 124), and possesses more numerous radial ribs with narrow furrows and strong concentric ribs instead of laminæ.

The concentric ribs distinguish *C. cancellata* from the forms described by

[1] 'Min. Conch.,' vol. iii (1820), p. 106, pl. cclix, fig. 3 (the original is now in the British Museum). *Venericardia* ? Mantell, 'Foss. S. Downs' (1822), p. 126.

[2] 'Pal. Franç. Terr. Crét.,' vol. iii (1844), p. 92, pl. cclxx, figs. 1—5. Guéranger, 'Album Paléont. de la Sarthe' (1867), p. 13, pl. xvi, figs. 14—18.

Geinitz[1] and by Reuss[2] as *C. tenuicosta.* The concentric ribs and the nodular character which they give to the radial ribs separate *C. cancellata* from *Venericardia santonensis*, Müller.[3]

Remarks.—The specimens of *C. cancellata* are chiefly in the form of internal and external moulds; wax casts of the latter show the character of the ornamentation. In a few cases small portions of the shell are still preserved.

Type.—From the Chalk Rock of Cuckhamsley, in the Sedgwick Museum.

Distribution.—Chalk Rock of Cuckhamsley, Aston Hill, Chinnor Hill, Thickthorn Hill (Bledlow), Boxmoor, Luton, and Wood Ditton.

Family—CRASSATELLITIDÆ, *Dall.*

Genus—Crassatellites, *J. F. Krüger*, 1823.

('Geschichte d. Urwelt.,' ii, p. 466.)

Crassatellites divisiensis, sp. nov. Plate XIX, fig. 1.

Description.—Shell subquadrate, very inequilateral, moderately long, convex, but with flattened sides, carinate. Anterior margin regularly rounded; ventral margin nearly straight, oblique to the postero-dorsal margin; posterior margin convex, oblique, forming an obtuse angle with the postero-dorsal margin, which is nearly straight. Umbones rather prominent, curved anteriorly. Carina rounded, forming a gentle curve between the umbo and the postero-ventral angle. Posterior area moderately large, apparently not divided by a median rib. Lunule deep.

Ornamentation consists of numerous, strong, regular, concentric ribs, separated by shallow furrows. On the posterior area the ribs appear to be narrower. Length 45 mm.; height 37 mm.

Affinities.—This species shows some resemblance to *C. Guerangeri*, d'Orbigny,[4]

[1] *C. Geinitzii*, d'Orbigny, 'Prodr. de Pal.,' vol. ii (1850), p. 239. For references to Geinitz's figures see above (p. 124).

[2] 'Die Verstein. der böhm. Kreideformat.,' pt. 2 (1846), p. 4, pl. xxxiii, fig. 16. *C. corrugata*, Reuss, 'Geogn. Skizzen aus Böhmen,' vol. ii (1844), p. 190; Gümbel, 'Abhandl. d. k. bayerisch. Akad.' (München), vol. x (1868), p. 568. *Cardita (Venericardia) bohemica*, Griepenkerl, 'Senon. Königslutter' ('Palæont. Abhandl.,' vol. iv, 1889), p. 58. See also *C. Cottaldina*, d'Orbigny, 'Prodr. de Pal.,' vol. ii (1850), p. 161.

[3] 'Mollusk. Untersen. v. Braunschweig u. Ilsede' (1898), p. 55, pl. vii, figs. 10—12.

[4] 'Pal. Franç. Terr. Crét.,' vol. iii (1844), p. 76, pl. cclxv, figs. 1, 2; Guéranger, 'Album Paléont. de la Sarthe' (1867), p. 13, pl. xvi, fig. 11.

but is more inequilateral, the ventral margin is nearly straight, the posterior margin is more oblique, and the posterior area is relatively smaller. It is much more inequilateral than *C. regularis*, d'Orbigny.[1] *C. divisiensis* also resembles some of the varieties of *C. macrodonta* (Sowerby)[2] from Gosau.

Distribution.—Upper Greensand (zone of *Schlœnbachia rostrata*) of Devizes. An imperfect specimen from Warminster (zone of *Pecten asper*) probably belongs to this species.

Crassatellites vindinnensis (*d'Orbigny*), 1844. Plate XIX, figs. 2, 3.

1844.	Crassatella vindinnensis, *A. d'Orbigny.*		Pal. Franç. Terr. Crét., vol. iii, p. 79, pl. cclxvi, figs. 1—3.
1850.	—	vendinnensis, *d'Orbigny.*	Prodr. de Pal., vol. ii, p. 160.
1867.	—	vindinnensis, *E. Guéranger.*	Album Paléont. de la Sarthe, p. 13, pl. xvi, figs. 9, 10.
? 1868.	—	— *C. W. Gümbel.*	Geogn. Beschreib. Königreichs Bayern, vol. ii, p. 766.
1871.	—	— *F. Stoliczka.*	Palæont. Indica, Cret. Fauna S. India, vol. iii, p. 294.

Description.—Shell subquadrate, but trigonal without the posterior area, very inequilateral, convex, with rounded carina. Anterior margin rounded, passing gradually into the slightly curved ventral margin; posterior margin oblique, somewhat sinuous; postero-dorsal margin nearly straight, forming an obtuse angle with the posterior margin. Lunule elongate, deep. Umbones prominent, incurved. Posterior area of moderate size, divided by a median rib into two parts, of which the anterior is concave.

Ornamentation consists of strong, regular, concentric ribs, separated by narrow furrows. On the posterior area the ribs become very narrow and more or less lamellar, and the interspaces are broad and flat.

Measurements:

	(1)	(2)
Length . . .	31 . .	30 mm.
Height . . .	26 . .	26 ,,

(1, 2) Dunscombe.

Affinities.—This species is related to *C. ligeriensis*, d'Orbigny,[3] and *C. Gueran-*

[1] *Op. cit.*, p. 80, pl. cclxvi, figs. 4—7.

[2] Zittel, "Bivalv. d. Gosaugeb." ('Denkschr. d. k. Akad. Wien, Math.-Nat. Cl.,' vol. xxv, pt. 2, 1866), p. 150, pl. viii, figs. 2, 3.

[3] 'Pal. Franç. Terr. Crét.,' vol. iii (1844), p. 77, pl. cclxv, figs. 3—5; Guéranger, 'Album Paléont. de la Sarthe' (1867), p. 13, pl. xvi, fig. 12.

geri, d'Orbigny,[1] but the posterior margin is more oblique and the posterior area relatively smaller.

Remarks.—The lamellar ribs on the posterior area are not mentioned by d'Orbigny, but attention is called to them by Guéranger.

I have seen only five specimens, which were collected by the late C. J. A. Meÿer, and are now in the Sedgwick Museum, Cambridge.

C. vindinnensis is the type of Conrad's[2] genus *Pachythærus*.

Types.—From the Cenomanian of Rouen and Le Mans.

Distribution.—Cenomanian (Meÿer's Beds 10 and 12) of Dunscombe, Devon.

Genus—Anthonya, *W. M. Gabb*, 1864.

('Geol. Surv. California, Palæont.,' vol. i, p. 181, pl. xxx, fig. 236.)

Anthonya cantiana, sp. nov. Plate XIX, figs. 4, 5.

Description.—Shell elongate, tapering posteriorly, very inequilateral, much compressed. Anterior margin slightly convex. Ventral margin long, moderately convex. Posterior margin short, truncate, forming angles with the ventral and dorsal margins. Postero-dorsal margin concave. Umbones acute, near the anterior end. A faint carina passes from the umbo to the postero-ventral angle and cuts off a flattened or slightly concave postero-dorsal area.

Ornamentation consists of numerous narrow, regular, concentric ribs over the whole surface of the shell. The ribs are separated by furrows of greater width than themselves.

Measurements :

	(1)	(2)
Length . . .	34	27 mm.
Height . . .	27	14 ,,

(1, 2) Folkestone Beds, near Copt Point.

Affinities.—This species is distinguished from *A. Cornueliana* (d'Orbigny)[3] by the shorter anterior part of the shell, the smaller apical angle, and by the ribs, which are of equal or nearly equal strength over the whole surface. It is less elongate and has a smaller apical angle than the type species *A. cultriformis*, Gabb.

[1] *Op. cit.*, p. 76, pl. cclxv, figs. 1, 2; Guéranger, *op. cit.*, p. 13, pl. xvi, fig. 11.

[2] 'Amer. Journ. Conch.,' vol. v (1869), p. 47.

[3] 'Pal. Franç. Terr. Crét.,' vol. iii (1844), p. 74, pl. cclxiv, figs. 7—9; referred to *Ptychomya* by Pictet and Campiche, 'Terr. Crét. Ste. Croix' ('Matér. Pal. Suisse,' ser. 4, 1866), p. 357; E. G. Skeat and V. Madsen, "Jur. Neoc. and Gault Boulders in Denmark" ('Danmarks geol. Undersög.,' vol. ii, No. 8, 1898), p. 178, pl. vi, fig. 13.

Remarks.—Only two specimens have been seen, both of which were collected by Mr. H. Keeping, and are now in the Sedgwick Museum, Cambridge.

Distribution.—Folkestone Beds, near Copt Point, Folkestone.

ANTHONYA, sp. Plate XIX, fig. 6.

Description.—Shell elongate, tapering posteriorly, very inequilateral, greatly compressed. Anterior margin convex, rounded, passing gradually into the slightly curved ventral margin. Posterior margin short, truncate, forming angles with the ventral and dorsal margins. Postero-dorsal margin long, slightly concave. Umbones sharp, anterior. Carina indistinct. Postero-dorsal area narrow. Surface of shell smooth, except for growth-lines, which are rather more distinct near the anterior margin than elsewhere.

Length, 38 mm. Height, 15 mm.

Affinities.—This species appears to be closely allied to *A. Cornueliana* (d'Orbigny),[1] but does not possess the concentric ribs near the anterior margin. It differs from *A. cantiana*, sp. nov., in the greater length of the anterior part of the shell, the greater curvature of the anterior margin, the larger apical angle, and the absence of concentric ribs.

Remarks.—A left valve is the only specimen seen.

Distribution.—Lower Greensand (Crackers) of Atherfield.

Family—CYPRINIDÆ, *Lamarck.*

Genus—CYPRINA, *Lamarck*, 1818.

('Anim. sans Vert.,' vol. v, p. 556)

CYPRINA SAUSSURI (*Brongniart*), 1821. Plate XIX, figs. 7—13.

1821. DONACITES SAUSSURI, *A. Brongniart.* Ann. des Mines, vol. vi, p. 555, pl. vii, fig. 5 (non *Venus Saussurii*, Goldfuss, 1840).

1854. MACTRA SAUSSURI, *E. Renevier.* Mém. géol. sur la Perte-du-Rhône, p. 24.

1856. CYPRINA SAUSSURI, *F. J. Pictet and E. Renevier.* Foss. Terr. Aptien (Matér. Pal. Suisse, ser. 1), p. 73, pl. viii, figs. 1—2.

[1] For references see p. 130, footnote 3.

1865. Cyprina Saussuri, *F. J. Pictet and G. Campiche.* Foss. Terr. Crét. Ste. Croix (Matér. Pal. Suisse, ser. 4), p. 220.

— *H. Coquand.* Mon. Aptien de l'Espagne, p. 113.

Description.—Shell usually of small or moderate size, sub-triangular, rounded, often cyreniform, convex, more or less considerably inequilateral. Lunular margin of moderate length, concave. Anterior margin regularly rounded, passing gradually into the convex ventral margin. Posterior margin short, often more or less rounded, sometimes truncate, forming an angle with the ventral margin, and not sharply limited from the long postero-dorsal margin. Umbones prominent, broad. Carina rounded, sometimes rather indistinct. Postero-dorsal area narrow. Lunular region deep, indistinctly limited. Escutcheon elongate, bounded by an inconspicuous carina. Hinge not seen. Ornamentation consists of growth-lines and numerous minute radial ribs.

Measurements:

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	
Length .	52	49	40	38·5	38	33	26	25·5	24	mm.
Height .	40	40	31	33	31	27	21	21·5	19	,,
Thickness	34	31	27	26		20	16		14	,,

(1, 2) *Perna*-bed, Atherfield.

(3—9) Crackers, Atherfield.

Affinities.—This species is related to *C. cuneata* (see p. 134), but the outline of the shell is less distinctly triangular, the sides are less flattened, the ventral margin is more convex, the umbones are broader and not so high, the lunular margin is not so long, and the carina is less distinct.

Remarks.—The relative height and length of the shell, and consequently the outline, vary considerably.

Much larger and more globose specimens (Plate XIX, fig. 13) in which the carina is indistinct, are associated with the normal forms of *C. Saussuri*, but are less abundant. At first sight, especially when the shell is not quite perfect, these appear to be distinct from *C. Saussuri*, but after comparing a number of specimens I am led to the conclusion that they are only old individuals which have attained a large size.

Examples of *C. Saussuri* from Atherfield were identified by Pictet and Campiche, but, hitherto, no record of the species appears to have been made by any English writer.

Type.—From the Aptian of the Perte-du-Rhône.

Distribution.—Lower Greensand (*Perna*-bed and Crackers) of Atherfield. Atherfield Beds of Haslemere and Redhill.

PLATE XII.

Gervillia (*continued*).

Figs.

1—5. *G. Forbesiana*, d'Orb. Gault, Folkestone. (P. 85.)

1. Sedgwick Museum. Left valve, × $\frac{5}{6}$.
2. British Museum, No. L 4918. Left valve.
3. Sedgwick Museum. Right valve.
4. ,, ,, Left valve.
5. ,, ,, Hinge of right valve, × $1\frac{1}{2}$.

Genus—Perna, *Bruguière.*

6—9. *P. Rauliniana*, d'Orb. Gault, Folkestone. (P. 92.)

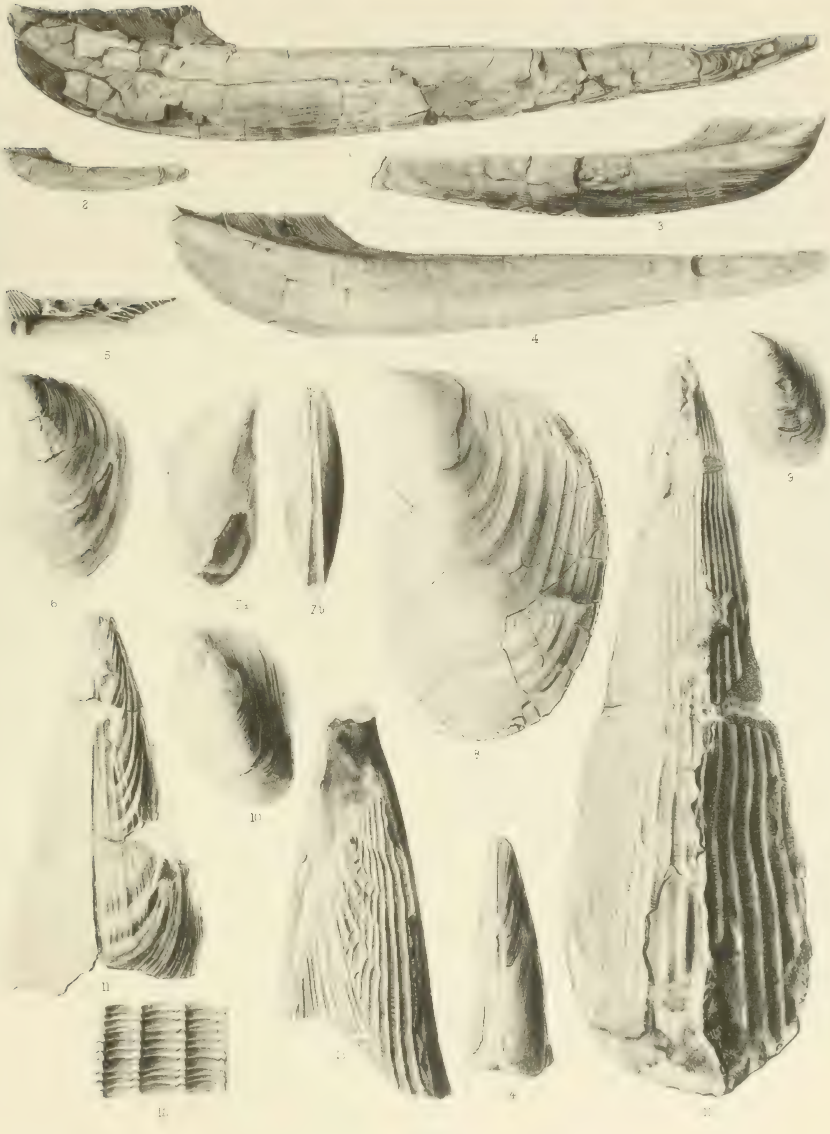
6. Sedgwick Museum. Left valve.
7. ,, ,, *a*, right valve; *b*, anterior view.
8. Museum of Practical Geology, No. 1605. Left valve.
9. ,, ,, ,, No. 12638. Left valve.

10. *P.* sp. Gault, Folkestone. Sedgwick Museum. Left valve. (P. 94.)

Genus—Pinna, *Linnæus.*

11–15. *P. Robinaldina*, d'Orb. Lower Greensand. (P. 96.)

11. Isle of Wight. Bristol Museum. Right valve.
12. *Crioceras* Beds, Atherfield. British Museum, No. 48626. Portion of dorsal half of left valve. × 3.
13. *Perna*-bed, Atherfield. Sedgwick Museum. Ventral part of left valve.
14. Crackers, Atherfield. Museum of the Geological Society, No. 2100. Right valve.
15. *Perna*-bed, Atherfield. Sedgwick Museum. Left valve.



T. A. Brock, del.

PLATE XIII.

PINNA (*continued*).

FIGS.

1\. *P. Robinaldina*, d'Orb. Lower Greensand, Isle of Wight. Museum of Practical Geology, No. 12636. Ventral part of right valve. (P. 96.)

2, 3. *P.* sp. Gault, Folkestone. 2. Sedgwick Museum; left valve. 3. Museum of Practical Geology, No. 12641; portion of dorsal part of left valve, × 6. (P. 99.)

4–6. *P. decussata*, Goldf. Chalk. (P. 99.)

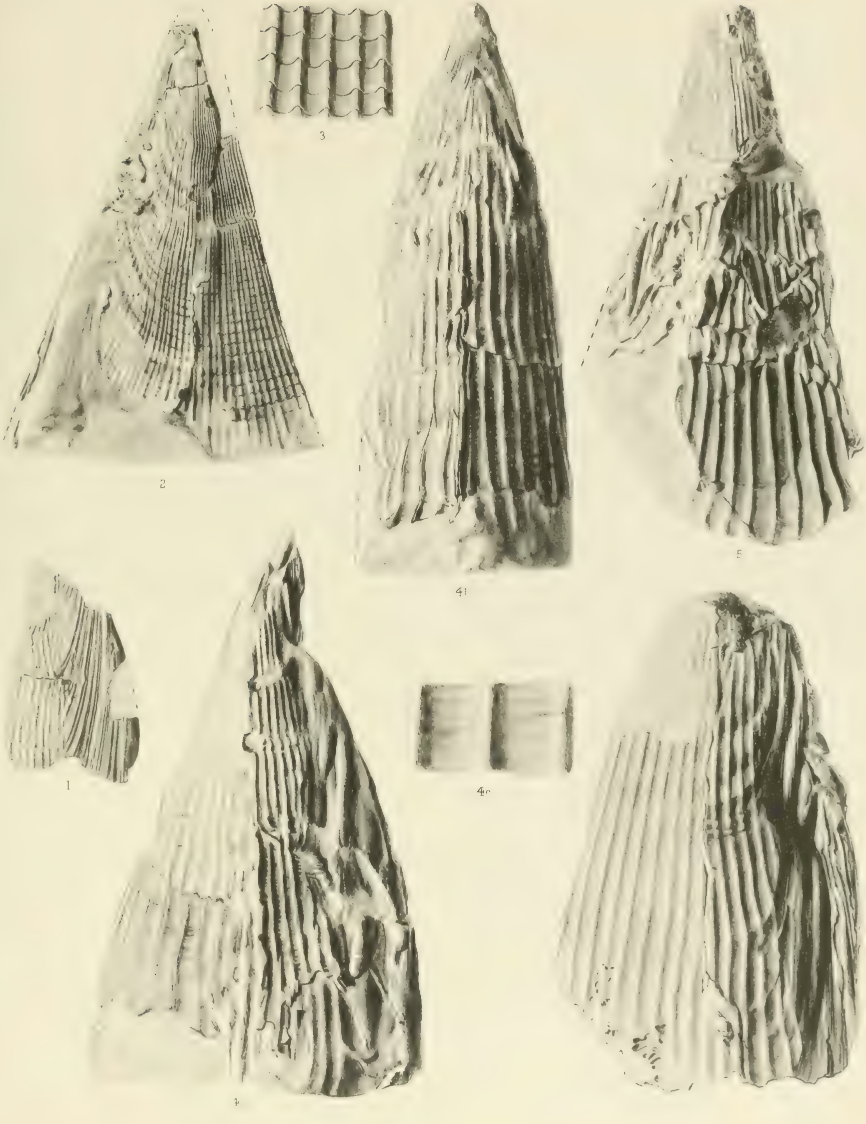
4\. Newtimber (Sussex). Brighton Museum. *a*, right valve; *b*, dorsal view of both valves; *c*, dorsal part of right valve, × 3.

5\. *Holaster planus* zone, Balsham. Sedgwick Museum. Left valve.

6\. Trimingham. Norwich Museum. Part of right valve.

PALÆONTOGRAPHICAL SOCIETY, 1906

V. I II PLATE XIII



[illegible] LAMELLI[illegible]

T A Brock del.

PLATE XIV.

PINNA (*continued*).

FIGS.

1. *P. decussata*, Goldf. Right valve. Zone of *Belemnitella mucronata*, Norwich. Norwich Museum. This specimen is the type of *P. sulcata*, Woodw. (P. 101.)

Genus—ASTARTE, *Sowerby*.

2, 3. *A. elongata*, d'Orb. Lower Greensand. Seend. Museum of Practical Geology, Nos. 13176, 13181. (P. 102.)
- 2 *a*, right valve; 2 *b*, dorsal view.
- 3. Internal cast of right valve.

4–6. *A. subacuta*, d'Orb. Lower Greensand (*Perna*-bed), East Shalford. Sedgwick Museum. (P. 103.)
- 4. Right valve.
- 5. Internal mould of right valve, × $1\frac{1}{2}$.
- 6. Portion of left valve.

7–9. *A. sinuata*, d'Orb. Lower Greensand (Crackers), Atherfield. Sedgwick Museum. (P. 104.)
- 7. Left valve, × $1\frac{1}{2}$.
- 8. Part of left valve.
- 9 *a*, right valve; *b*, dorsal view, × $1\frac{1}{2}$.

10–12. *A. upwarensis*, Woods. Lower Greensand, Upware. (P. 105.)
- 10. Sedgwick Museum. Specimen figured by W. Keeping. *a*, right valve; *b*, anterior view; *c*, portion near the middle of the valve, × 3.
- 11. Sedgwick Museum. *a*, left valve; *b*, dorsal view.
- 12. Mr. J. F. Walker's Collection. Hinge of right valve, × $1\frac{1}{2}$.

13–20. *A. senecta*, Woods. 13–16. Speeton Clay, Speeton. 17–20. Claxby Ironstone, Benniworth Haven. Sedgwick Museum, except fig. 16—York Museum. (P. 106.)
- 13. Left valve.
- 14. Right valve.
- 15 *a*, left valve; *b*, dorsal view.
- 16–18. Left valves.
- 19, 20. Interiors of left and right valves.

21. *A.* sp. Speeton Clay, Speeton. Sedgwick Museum. *a*, right valve; *b*, median part, × 5. (P. 107.)

22–24. *A. cantabrigiensis*, Woods. Lower Greensand, Upware. Sedgwick Museum. (P. 107.)
- 22 *a*, right valve; *b*, dorsal view.
- 23 *a*, right valve; *b*, anterior view.
- 24. Left valve.

25–28. *A. claxbiensis*, Woods. 25. Spilsby Sandstone, Spilsby. 26–28. Claxby Ironstone, Benniworth Haven. Sedgwick Museum, except fig. 27—York Museum. (P. 108.)
- 25 *a*, left valve; *b*, interior; *c*, dorsal view.
- 26, 27. Left valves, × $1\frac{1}{2}$.
- 28 *a*, right valve; *b*, dorsal view.

29–36. *A. subcostata*, d'Orb. 29–35. Atherfield Beds. (P. 109.)
- 29. Peasmarsh. Museum of the Geological Society, No. 2181. *a*, right valve, × 2; *b*, part near the middle of the ventral margin, × 6.
- 30–35. Sevenoaks. British Museum, No. L 9284. 30, 31, 32, 35, right valves, × 2. 34, right valve, nat. size. 33, left valve, × 2.
- 36. *Perna*-bed, East Shalford. Sedgwick Museum. Left valve, × $1\frac{1}{2}$.

CRETACEOUS LAMELLIBRANCHIA.

T. A. Brock del.

London Stereoscopic Co. imp.

PLATE XV.

Astarte (*continued*).

Figs.

1, 2. *A. subcostata*, d'Orb., var. Lower Greensand (Crackers), Atherfield. Sedgwick Museum. (P. 110.)

1 *a*, right valve, × $1\frac{1}{2}$; *b*, anterior view, × $1\frac{1}{2}$.
2 *a*, right valve, × $1\frac{1}{2}$; *b*, dorsal view, × $1\frac{1}{2}$.

3, 4. *A.*, sp. Folkestone Beds, Folkestone. 3, right valve; 4, left valve. Sedgwick Museum. (P. 111.)

5–7. *A. Omalioides*, Woods. Gault, Folkestone. British Museum, No. L 4958. 5, 7, left valves; 6, right valve. × 2. (P. 111.)

8–13. *A. formosa*, Sow. Upper Greensand, Blackdown. Sedgwick Museum. All × 3. (P. 112.)

8. Left valve.
9 *a*, left valve; *b*, interior.
10 *a*, right valve; *b*, dorsal view; *c*, anterior view.
11. Left valve.
12. Interior of right valve.
13. Right valve.

14. *A. impolita*, Sow. Upper Greensand, Blackdown. The Type. Bristol Museum. Right valve. (P. 113.)

15–18. *A.* (*Eriphyla*) *obovata*, Sow. Lower Greensand (*Perna*-bed). Sedgwick Museum. (P. 113.)

15. Atherfield. Right valve.
16. Sandown. Right valve.
17. Atherfield. *a*, left valve; *b*, dorsal view.
18. Sandown. *a*, right valve; *b*, hinge.

CRETACEOUS LAMELLIBRANCHIA

Brock, del

London Stereoscopic Co imp.

PLATE XVI.

ASTARTE (*continued*).

FIGS.

1–3. *A.* (*Eriphyla*) *obovata*, Sow. (P. 113.)

1. *Perna*-bed, Atherfield. Left valve. Sedgwick Museum.
2. *Perna*-bed, Sandown. Left valve. Sedgwick Museum.
3. Upper Greensand, Blackdown. Hinge of left valve. Museum of Practical Geology, No. 13184.

4. ? Variety of *A.* (*Eriphyla*) *obovata*, Sow. *Perna*-bed, Sandown. York Museum. Left valve.

5–7. *A.* (*Eriphyla*) *lævis* (Phill.). Claxby Ironstone, Benniworth Haven. Sedgwick Museum. (P. 115.)

5 *a*, left valve ; *b*, interior ; *c*, dorsal view.
6 *a*, left valve ; *b*, anterior view.
7 *a*, right valve ; *b*, part of inner margin

PALÆONTOGRAPHICAL SOCIETY, 1906.

Vol II PLATE X

[illegible]

T. A. Br[illegible] del. [illegible] imp.

PLATE XVII.

Astarte (*continued*).

Figs.

1. *A.* (*Eriphyla*) *lævis* (Phill.). Claxby Ironstone, Benniworth Haven. Left valve. York Museum. (P. 115.)

2–7. *A.* (*Eriphyla*) *striata*, Sow. Upper Greensand, Blackdown. (P. 116.)

2. British Museum, No. L 587. *a*, right valve; *b*, interior of the same; *c*, dorsal view.
3. Sedgwick Museum. Interior of left valve (the teeth are drawn in part from a specimen in the Museum of Practical Geology, No. 13187).
4. British Museum, No. L 17076. Right valve.
5. Bristol Museum, No. 536. Right valve.
6. Museum of Practical Geology, No. 13188. Right valve.
7. Bristol Museum. The Type of *Astarte concinna*, Sow. Left valve.

Genus—Opis, *Defrance.*

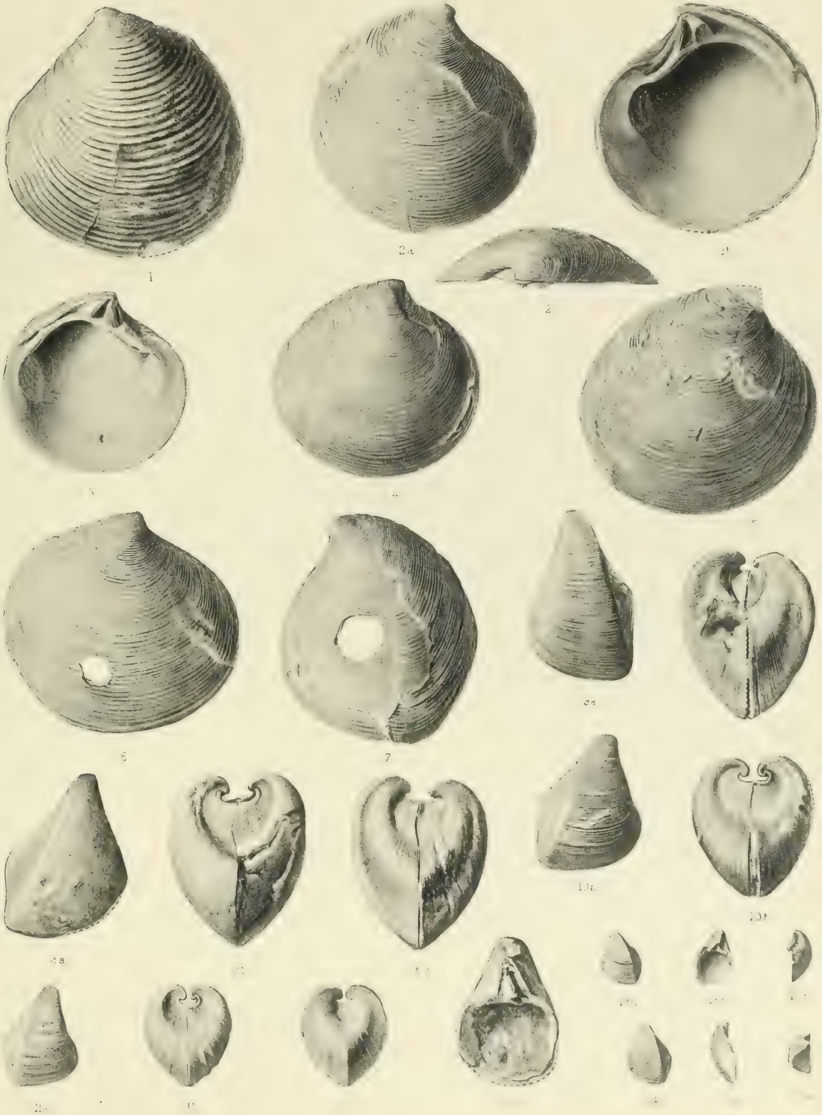
8–12. *O. neocomiensis*, d'Orb. Lower Greensand, Upware. (P. 118.)

8. Sedgwick Museum. *a*, right valve; *b*, anterior view of both valves; *c*, posterior view.
9. Sedgwick Museum. *a*, left valve; *b*, posterior view.
10. Sedgwick Museum. *a*, right valve; *b*, anterior view.
11. Mr. J. F. Walker's Collection. *a*, right valve; *b*, anterior view; *c*, posterior view.
12. Mr. Walker's Collection. Interior of right valve.

13, 14. *O.* sp. Upper Greensand, Haldon. British Museum, No. L 17144. (P. 120.)

13 *a*, left valve; *b*, interior; *c*, anterior view.

14 *a*, left valve; *b*, posterior view; *c*, dorsal view.



T. A. Brock, del.

PLATE XVIII.

Opis (*continued*).

Figs.

1. *Opis haldonensis*, Woods. Upper Greensand, Haldon. British Museum, No. L 17143. *a*, exterior; *b*, interior of right valve; *c*, posterior view of the same; *d*, anterior view. (P. 119.)

Genus—Cardita, *Bruguière*.

2–4. *C.? fenestrata* (Forbes). Lower Greensand (*Perna*-bed), Atherfield. (P. 121.)

2. Museum of Practical Geology, No. 14360. *a*, left valve; *b*, dorsal view, × $1\frac{1}{2}$; *c*, median part of left valve, × 4.
3. Sedgwick Museum. Right valve, × $1\frac{1}{2}$.
4. Sedgwick Museum. *a*, left valve; *b*, anterior view.

5. *C. upwarensis*, Woods. Lower Greensand, Upware. Sedgwick Museum. *a*, right valve; *b*, dorsal view; *c*, anterior view; *d*, part near the middle of the right valve, × 4. (P. 122.)

6. *C.* sp. Lower Greensand (*Perna*-bed), Atherfield. Sedgwick Museum. *a*, left valve; *b*, dorsal view; *c*, part near the middle of left valve, × 5. (P. 123.)

7–14. *C. tenuicosta* (Sow.). Gault, Folkestone. 7–13. Sedgwick Museum. 14. British Museum, No. 48135. (P. 124.)

7. Left valve, × $1\frac{1}{2}$.
8 *a*, left valve; *b*, anterior view.
9. Right valve.
10 *a*, left valve; *b*, dorsal view; *c*, part near the mid-ventral border, × 6.
11 *a*, right valve, × $1\frac{1}{2}$; *b*, dorsal view, × $1\frac{1}{2}$; *c*, part near the middle of the right valve, × 6.
12. Left valve. × 2.
13. Inflated variety. *a*, right valve; *b*, dorsal view.
14. Short and much inflated variety. *a*, right valve; *b*, dorsal view.

15, 16. *C. Cottaldina*, d'Orb. Chloritic Marl. (P. 126.)

15. Toller Fratrum. Museum of Practical Geology, No. 14348. Right valve.
16. Chard. Oxford Museum. *a*, left valve; *b*, dorsal view.

17, 18. *C. cancellata*, Woods. Chalk Rock, Cuckhamsley. Sedgwick Museum. (P. 127.)

17 *a*, wax cast of right valve, × $1\frac{1}{2}$; *b*, ornamentation near the middle of the right valve, × 5.
18. Natural internal cast. *a*, left valve; *b*, anterior view.

T. A. Brock, del.

PLATE XIX.

Genus—Crassatellites, *Krüger.*

Figs.

1. *C. divisiensis*, Woods. Upper Greensand, Devizes. Museum of Practical Geology, No. 16750. *a*, left valve; *b*, dorsal view. (P. 128.)

2, 3. *C. vindinnensis* (d'Orb.). Cenomanian (Meÿer's Bed, 10), Dunscombe. Sedgwick Museum. (P. 129.)

2 *a*, left valve; *b*, dorsal view; *c*, ornamentation near the middle of the valve, × 4; *d*, ornamentation on the posterior area, × 4.
3. Right valve.

Genus—Anthonya, *Gabb.*

4, 5. *A. cantiana*, Woods. Folkestone Beds, Folkestone. Sedgwick Museum. Right valves. 5 *b*, part near the mid-ventral border, × 5. (P. 130.)

6. *A.* sp. Lower Greensand (Crackers), Atherfield. Sedgwick Museum. Left valve. (P. 131.)

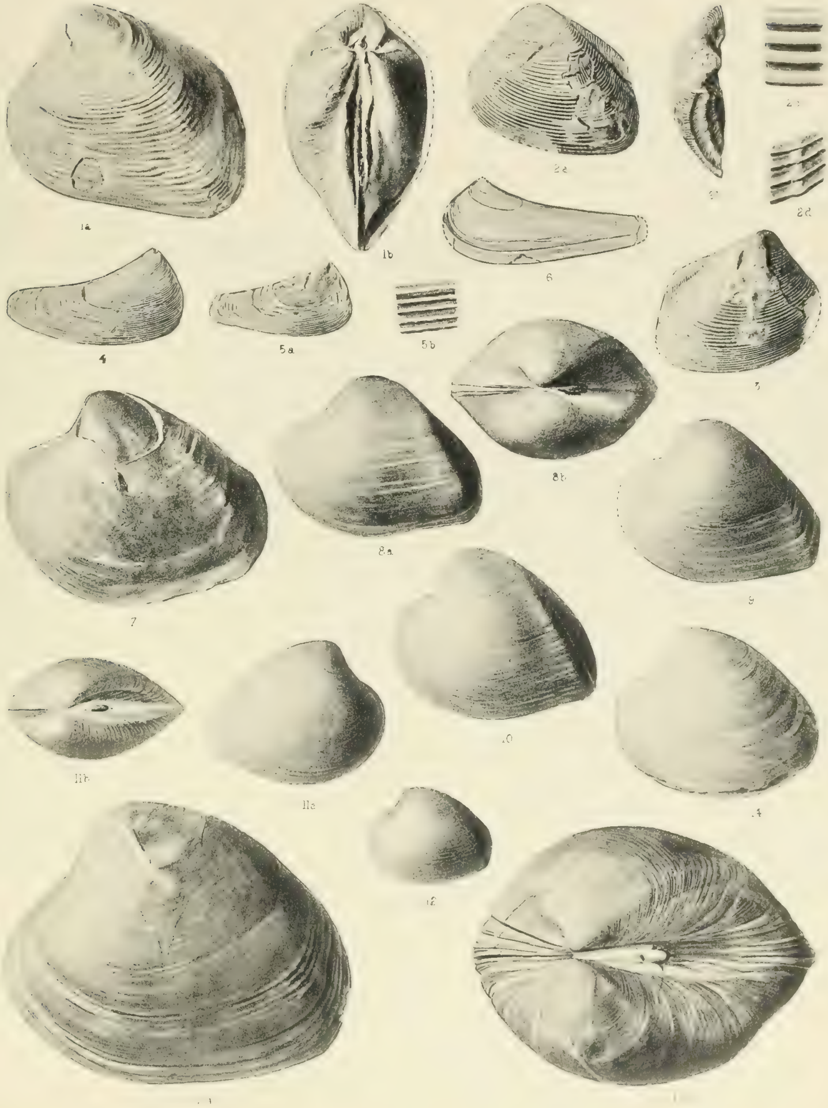
Genus—Cyprina, *Lamarck.*

7–13. *C. Saussuri* (Brongn.). Lower Greensand (Crackers), Atherfield (except fig. 7, *Perna*-bed). Sedgwick Museum, except fig. 13. (P. 131.)

7. Left valve.
8 *a*, left valve; *b*, dorsal view.
9, 10. Left valves
11 *a*, right valve; *b*, dorsal view.
12. Left valve.
13. British Museum, No. L 564. Large form. *a*, left valve; *b*, dorsal view.

14. *C. Sedgwicki* (Walker). Lower Greensand, Upware. Sedgwick Museum. Left valve. (P. 133.)

PALÆONTOGRAPHICAL SOCIETY, 1906.



T. A Brock, del.

THE

PALÆONTOGRAPHICAL SOCIETY.

INSTITUTED MDCCCXLVII.

VOLUME FOR 1906.

LONDON

MDCCCCVI.

THE LOWER PALÆOZOIC TRILOBITES OF THE GIRVAN DISTRICT, AYRSHIRE.

ORDER OF BINDING AND DATES OF PUBLICATION.

PAGES	PLATES	ISSUED IN VOL. FOR YEAR	PUBLISHED
Title-page and Index	—	1906	December, 1906
1—48	I—VI	1903	December, 1903
49—96	VII—XIII	1904	December, 1904
97—186	XIV—XX	1906	December, 1906

THE

LOWER PALÆOZOIC TRILOBITES

OF THE

GIRVAN DISTRICT, AYRSHIRE.

BY

F. R. COWPER REED, M.A., F.G.S.,
TRINITY COLLEGE, CAMBRIDGE.

LONDON:
PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.
1903—1906.

PRINTED BY ADLARD AND SON, LONDON AND DORKING.

Palæontographical Society, 1906.

THE

LOWER PALÆOZOIC TRILOBITES

OF THE

GIRVAN DISTRICT, AYRSHIRE.

BY

F. R. COWPER REED, M.A., F.G.S.,
TRINITY COLLEGE, CAMBRIDGE.

PART III.

Pages 97—186, Title-page and Index; Plates XIV—XX.

LONDON:
PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.
1906.

PRINTED BY ADLARD AND SON, LONDON AND DORKING.

inner convex portion and a flattened border widening towards the obtusely pointed (?) genal angle. The facial suture is not clearly seen, but appears to cut the posterior margin about halfway out between the axial furrow and the genal angle. The neck-segment behind the glabella is broad in the middle and arched forwards, bending back strongly and decreasing in width behind the occipital lobes. Behind the cheeks it widens and forms a strong rounded ring. The neck-furrow is deep and well marked.

The thorax consists of eleven segments, and is as long as the head; the axis is broad, convex, and tapering gradually to the pygidium, and is as wide as the pleural portions. The axial rings are rather narrow, and arched forwards. The pleuræ are strongly bent downwards outside the feeble fulcrum; the inner portion is nearly horizontal. Each pleura is narrow, with a sub-median, slightly diagonal furrow dividing it into a rounded anterior and a posterior portion; the posterior portion is rather the larger and bears a row of 3—4 tubercles like the neck-segment.

The pygidium is imperfectly known (Nicholson and Etheridge's figure is very poor), but it apparently resembles *L. wesenbergensis*, Schm.,[1] and its allies. There is an imperfect cast of a pygidium from the Starfish Bed in Mrs. Gray's collection which most probably belongs to this species, judging from the type specimen. Its characters are the following: Shape sub-quadrate, as long as wide. Axis convex, conical, about half the length of pygidium, bearing three complete rings at anterior end, followed by 3—4 incomplete rings with the transverse furrows obsolete at the sides. Each ring bears a single row of 2—4 tubercles. A narrow post-axial ridge runs to a median notch in posterior margin. Lateral lobes slightly arched, consisting of three pairs of pleuræ. The first two pairs lanceolate, subequal, and curved backwards with free pointed extremities and median pleural furrow. Third pair of pleuræ short, broad, expanding towards posterior pygidial margin, without pleural furrow. Extremities not preserved, but separated by median notch in margin. The extremities of the first and second pair of pleuræ extend back as far as the posterior margin of the pygidium.

The ornamentation of the whole pygidium consists of granulations with small scattered tubercles. A single row of 4—5 larger tubercles marks the posterior half of both the first and the second pleuræ.

Remarks.—The type specimen from Drummuck figured by Nicholson and Etheridge (*op. cit.*) left something to be desired in its state of preservation; and therefore the above detailed description has been given on the strength of a better preserved and nearly perfect example consisting of a good head-shield with ten thoracic segments attached to it.

Affinities.—By the lobation of the glabella, and position and development of

[1] Schmidt, 'Rev. Ostbalt. Silur. Trilob.,' pt. ii (1885), p. 44, pl. vi, figs. 1—4.

the furrows of the head-shield, this species bears a considerable resemblance to *L. wesenbergensis*, Schmidt. The pygidium also is of the same type, though differing in minor details. We may consider them as closely allied forms.

Collections.—Mrs. Gray; Edinburgh Museum (f. M.).

Horizon and Localities.—Drummuck Group (U. Bala): Drummuck; Starfish Bed, Thraive Glen.

3. **Lichas (Corydocephalus) scutalis,** Salter, 1873. Plate XIV, figs. 3, 4.

1873. *Lichas scutalis*, Salter, MS., Cat. Camb. Silur. Foss. Woodw. Mus., p. 130.
1877. *Lichas verrucosus*, Woodward, Cat. Brit. Foss. Crust., p. 43.
1878. *Lichas scutalis*, Edgell, MS., Cat. Camb. Silur. Foss. Mus. Pract. Geol., p. 84.
1891. *Lichas verrucosus*, Woods, Cat. Type Foss. Woodw. Mus., p. 147.
1899. *Lichas ambigua* (Barrande), Mem. Geol. Surv., Silur. Rocks Brit., vol. i, Scotland, pp. 532, 689.
1901. *Lichas scutalis*, Reed, Geol. Mag. [4], vol. viii, p. 5, pl. i, figs. 1—4.
1902. *Lichas* (*Corydocephalus*) *scutalis*, Reed, Quart. Journ. Geol. Soc., vol. lviii, pp. 71, 82.

The species *L. scutalis* is represented from the Lower and Middle Llandovery Beds of Girvan by pygidia and head-shields. The pygidia agree essentially with the type from the Wenlock of Dudley,[1] except in having the axis rather shorter and, consequently, the triangular post-axial piece and ridge rather longer; the forked posterior points of the margin are also rather more elongate and acute. But these are trifling differences, perhaps pointing to a local variety. The head-shields show all the typical features. These specimens were recorded in the Survey Memoir[2] as "*L. ambigua*, Barrande."

Collection.—Mrs. Gray.

Horizons and Localities.—Mulloch Hill Group (L. Llandovery): Mulloch Hill; Craigens. Saugh Hill Group (M. Llandovery): Newlands; Woodland Point.

4. **Lichas (Corydocephalus) wesenbergensis,** Schmidt, 1885. Var.? Plate XIV, fig. 2.

1857. *Lichas laticeps*, Nieszkowski (*non* Angelin), Mon. Trilob. Ostseeprov. in Archiv. Liv. Est. Kurlands, ser. 1, vol. i, p. 577, pl. vi, fig. 20 (*e.p.*).
1858. *Lichas sexpunctatus*, Hoffmann, Sämmt. Trilob. Russl. (Verh. Miner. Gesell., Jahrg. 1857–58), p. 24, pl. i, figs. 4—8 (?).
1885. *Lichas (Arges) wesenbergensis*, Schmidt, Rev. Ostbalt. Silur. Trilob., pt. ii, p. 44, pl. vi, figs. 1—4.
1901. *Lichas* (*Hemiarges*) *wesenbergensis*, Gürich, Neues Jahrb. f. Min., Beil. Bd. xiv, p 526.
1902. *Lichas wesenbergensis*, Reed, Quart. Journ. Geol. Soc., vol. lviii, p. 71.

[1] Reed, 'Geol. Mag.' [4], vol. viii (1901), p. 5, pl. i, figs. 1—4.

[2] 'Mem. Geol. Surv., Silur. Rocks Brit.,' vol. i, Scotland (1899), Appendix, p. 689.

Specific Characters.—Pygidium transversely subquadrate, nearly twice as broad as long. Axis short, broad, convex, rather more than half the length of the pygidium, and occupying the middle third of its width, scarcely tapering at all posteriorly, abruptly truncated, and connected with posterior margin by narrow, low, straight, post-axial ridge (as in typical members of the section *Corydocephalus*). Two axial rings appear to be present at the front end of the axis, but this part is not well preserved. Lateral lobes bent down, consisting of three pairs of pleuræ. First two pairs of pleuræ subequal, lanceolate, strongly bent back beyond the approximate fulcrum, and produced into free points beyond margin. The points of the second pair extend beyond the posterior end of the pygidium. Each of the two first pairs of pleuræ is marked with a submedian pleural furrow. Third pair of pleuræ very short and broad, without pleural furrows; separated in middle by post-axial ridge and deep narrow notch in pygidial margin. Each pleura of the third pair ends on the margin with two points. Ornamentation not preserved.

Remarks.—This peculiar little pygidium, of which I have only seen the one example here figured, agrees with *L. wesenbergensis*, Schmidt,[1] in its general characters, and especially in the double-pointed third pleuræ. It differs in its more transverse shape, the stronger backward curvature of the two first pairs of pleuræ, and in the prolongation of the second pair behind the posterior margin. From *L. geikiei* it differs in the shape of the axis, the greater width of the pygidium, and the prolongation of the second pair of pleuræ; and it comes from a different stratigraphical horizon. A supposed variety of *L. wesenbergensis* has been described by Clarke[2] as var. *paulianus* from the Trenton Limestone of Minnesota, but the small pygidium figured by him differs more than ours does from the typical Russian examples of the species.

Collection.—Woodwardian [Sedgwick] Museum.

Horizon and Locality.—Balclatchie Group (Llandeilo): Dow Hill.

5. **Lichas (Platylichas) grayi,** Fletcher, 1850.

1848. *Lichas*, sp. ind., Salter, Mem. Geol. Surv., vol. ii, pt. i, p. 340, pl. viii, fig. 8.

1850. *Lichas grayii*, Fletcher, Quart. Journ. Geol. Soc., vol. vi, p. 237, pl. xxvii, fig. 8; pl. xxvii *bis*, figs. 3, 3*a*, 3*b*.

1854. *Lichas grayii*, Morris, Cat. Brit. Foss., 2nd ed., p. 110.

[1] Schmidt, 'Rev. Ostbalt. Silur. Trilob.,' pt. ii, pl. vi, fig. 2.

[2] Clarke, 'Lower Silur. Trilob. Minnesota, p. 744, figs. 62—64 (Final Rep. Geol. Nat. Hist. Surv. Minnes., vol. iii, 1894).

1885. *Lichas grayi*, Lindström, Förteckn. Gotl. Silur. Crust. (Ofv. k. vet. Akad. Förhandl., No. 6), p. 60.

1902. *Lichas (? Platylichas) grayi*, Reed, Quart. Journ. Geol. Soc., vol. lviii, p. 72.

Var. nov. **scoticus.** Plate XIV, figs. 5—10.

? 1854. *Lichas rotundifrons*, Angelin, Pal. Scand., p. 70, pl. xxxvi, figs. 7, *7a*, *7b*.

1873. *Lichas bulbiceps ?*, Salter, Cat. Camb. Silur. Foss. Woodw. Mus., p. 77.

1878. *Lichas grayii ?*, Nicholson and Etheridge, Mon. Silur. Foss. Girvan, fasc. i, p. 134, pl. ix, figs. 11, 12.

1878. *Lichas barrandei ?*, Nicholson and Etheridge, ibid., p. 132, pl. ix, fig. 8.

Remarks.—In addition to the single head-shield from Mulloch Hill figured by Nicholson and Etheridge (*op. cit.*) as doubtfully belonging to *L. grayi*, Fletcher, there are several others from the same locality, and one from Craigens, which enable us to describe the characters of this form more in detail. A large fragment of a glabella from Camregan Wood, also in Mrs. Gray's collection, probably belongs to it; and the specimen in the Woodwardian [Sedgwick] Museum from Mulloch, called by Salter (*op. cit.*) "*L. bulbiceps*, Phillips ?" appears to be a crushed head-shield of the same species.

The Mulloch Hill and Craigens specimens differ from the typical *L. grayi* of the English Wenlock by (1) the strong deflection of the anterior portion of the head-shield; (2) the shorter central lobe of the glabella, and its more rapid and greater expansion in front, so as to overlap the bicomposite lobes to a greater extent; (3) the broader and more oval shape of the bicomposite lobes, their relative shortness and stronger convergence posteriorly; (4) the narrowness of the neck of the central lobe; (5) the stronger convergence posteriorly of the axial furrows; and (6) the generally greater convexity of the head-shield.

In other respects this Scottish form has the closest resemblance to the English Wenlock species, and it does not seem possible to regard it as more than a distinct variety which may be appropriately termed *scoticus*. *L. rotundifrons*, Angelin,[1] from the equivalent of the Wenlock Shales of Scotland, may prove to be identical with this Girvan form, as it seems to differ from the typical *L. grayi* in much the same way. Lindström[2] considered *L. rotundifrons*, Ang., to be identical with *L. grayi*, Fletcher, but this is very doubtful.

In addition to the above head-shields there are certain pygidia, also from Mulloch Hill and Craigens, which most probably ought to be referred to the same variety on the strength of their resemblance to *L. margaritifer*, Nieszk., which is the type[3] of the group of *Lichas* to which *L. grayi* may now be referred with certainty from

[1] Angelin, 'Pal. Scand.,' p. 70, pl. xxxvi, figs. 7, *7a*, *7b*.

[2] Lindström, 'Förteckn. Gotl. Silur. Crust.' (Ofv. k. vet. Akad. Förhandl., No. 6), 1885, p. 60.

[3] Reed, 'Quart. Journ. Geol. Soc.,' vol. lviii (1902), p. 72, figs. 3 *a*, *b*.

our knowledge of the critical characters of the head-shield. One from Mulloch Hill (now in the Museum of Practical Geology) was figured by Nicholson and Etheridge (*op. cit.*) as *L. barrandei ?*, but it differs from that species in several important particulars, as the following description shows :

Pygidium parabolic, wider than long. Axis subcylindrical, convex, less than one third the width of the pygidium, and about half its length; extremity rounded, undefined. Articulating half-ring present on front end of axis followed by three complete well-marked rings and a fourth faintly defined one. Axial furrows straight at sides of axis, curving inwards gently at its extremity, produced behind it, and near their blind ends again curving outwards, but not reaching posterior margin. Post-axial piece flattened, about half the length of pygidium, enclosed for its anterior two thirds by the produced axial furrows. Lateral lobes flattened, consisting of three pairs of pleuræ, each with a pleural furrow, and ending in short free points on the margin. First pleura increasing in width to remote fulcrum, beyond which it tapers rapidly to short recurved free point. First pleural furrow parallel to first interpleural furrow, which makes an angle of about 45° with the front edge. Second pleura marked by pleural furrow with second interpleural furrow nearly parallel to it, and making an angle of about 60° to front edge of pygidium. Third pleura with short median furrow, and only partially marked off from post-axial piece by the incomplete produced axial furrows. The third pair of pleuræ end in short free points closely placed together, giving a characteristic bifurcate appearance to the pygidium. All the furrows on the lateral lobes are apparently of equal strength, and the whole surface of the pygidium is tuberculate.

Two hypostomes, one from Rough Neuk, Mulloch, and the other from Woodland Point, in Mrs. Gray's collection, which may belong to *L. grayi* var. *scoticus*, have the following characters :

Transversely subquadrate in shape, with gently convex body, nearly twice as wide as long, and enclosed by strong furrows. Front of body strongly arched forward, sides straight, converging posteriorly at about 60°—70°, posterior end gently arched backward; sides of body indented at about two-thirds their length by deep, short, slightly oblique furrows, expanding at their inner ends and leaving a narrow transverse lobe behind them. Border wide, flattened, expanded and swollen at sides, and forming a pair of broad, rounded, posterior marginal lobes, more than half as long as the body. Posterior notch between them wide and shallow. Surface of body ornamented with coarse granulations; surface of border marked with faint striæ parallel to its outer edge.

Collections.—Mrs. Gray (f. M.) ; Museum of Practical Geology (f. M.) ; Woodwardian [Sedgwick] Museum.

Horizons and Localities.—Mulloch Hill Group (L. Llandovery) : Mulloch Hill ; Craigens ; ? Rough Neuk. ? Saugh Hill Group (M. Llandovery) : Woodland Point. Camregan Group (U. Llandovery) : Camregan Wood.

6. **Lichas (Platylichas) laxatus,** M'Coy, 1846. Plate XIV, figs. 11—13.

1846. *Lichas laxata*, M'Coy, Synops. Silur. Foss. Ireland, p. 51, pl. iv, fig. 9.
? — *Lichas pumila*, M'Coy, ibid., p. 52, pl. iv, fig. 8.
— *Calymene? forcipata*, M'Coy (*e.p.*), ibid., p. 48, pl. iv, fig. 14 (tail).
1848. *Lichas laxatus*, Salter, Mem. Geol. Surv., vol. ii, pt. i, p. 340, pl. viii, figs. 4, 5, 6.
1851. *Lichas laxatus*, Salter, Quart. Journ. Geol. Soc., vol. vii, p. 172, pl. ix, fig. 5.
1854. *Lichas laxatus*, Morris, Cat. Brit. Foss., 2nd ed., p. 110.
? — *Lichas sexspinus*, Angelin, Pal. Scand., p. 74, pl. xxxviii, figs. 7, 8.
? — *Lichas aculeatus*, Angelin, ibid., p. 75, pl. xxxviii, fig. 11.
1866. *Lichas laxatus*, Salter, Mem. Geol. Surv., vol. iii, p. 324, pl. xix, figs. 1—3.
— *Lichas segmentatus*, Linnarsson, Silur. bildn. i. mell. Vesterg., p. 18, pl. xi, fig. 4
1867. *Lichas laxatus*, Murchison, Siluria, 4th ed., p. 204, foss. 46, fig. 5.
1869. *Lichas laxatus*, Linnarsson, Vestergotl. Camb. Silur. Aflagr., p. 66.
1873. *Lichas laxatus*, Salter, Cat. Camb. Silur. Foss. Woodw. Mus., p. 50.
1875. *Lichas laxatus*, Baily, Figs. Char. Brit. Foss., p. 40, pl. xiii, figs. 7*a*, *b*.
1877. *Lichas laxatus*, Woodward, Cat. Brit. Foss. Crust., p. 43.
1878. *Lichas laxatus*, Nicholson and Etheridge, Mon. Silur. Foss. Girvan, fasc. i, p. 131.
— *Lichas*, sp. ind., Nicholson and Etheridge, ibid., p. 135, pl. ix, figs. 13, 14.
1884. *Lichas laxatus*, Törnquist, Siljansom. Trilobitf. (Sver. Geol. Undersökn., Ser. C, No. 66), p. 31.
1885. *Lichas laxatus*, Schmidt, Rev. Ostbalt. Silur. Trilob., pt. ii, p. 125.
1896. *Lichas laxatus*, Reed, Quart. Journ. Geol. Soc., vol. lii, p. 427.
1902. *Lichas laxatus*, Reed, Quart. Journ. Geol. Soc., vol. lviii, pp. 76, 82.

Remarks.—There is an interesting, though imperfect, specimen of this common but imperfectly known species in Mrs. Gray's collection from Thraive Glen, showing a portion of a head-shield, with the free cheek bearing the eye in a remarkably good state of preservation, and ten segments of the thorax attached. The minute structure of the eye of this species does not appear to have been previously described. In this example the large semicircular prominent eye-lobe is bent slightly upwards, has a broad swollen margin, and is marked off from the small fixed cheek by a wide but shallow groove. The eye itself is lunate, very large, with a high vertical lens-bearing surface, like *Phacops*, slightly higher at the anterior than the posterior end, and with a narrow furrow round its base. The lenses are hexagonal, very minute, closely packed and arranged in numerous vertical rows. Across the middle of the eye there are 40—50 lenses in one vertical row. So far as the characters can be made out, the eye has the structure of the Asaphids, and belongs to Lindström's Group I in his classification of trilobites according to the structure of the eyes.[1]

In the thorax the axis is cylindrical, gently convex, and hardly tapering at all posteriorly. Each axial ring has a rounded articulating band, arched forwards, on

[1] Lindström, 'Kongl. Svensk. Vet. Akad. Handl.,' vol. xxxiv, No. 8 (1901), pp. 26, 27.

the front edge. The pleuræ are flat, horizontal, and quite straight as far out as the fulcrum, which is situated at about two thirds the width of the axis from the axial furrow. The extra-fulcral portion of each pleura (well preserved in another specimen from the same locality) is gently recurved and tapers to a free point. A diagonal furrow crosses the whole pleura, and is continued almost to the free extremity. The fulcrum is weak and rounded. The pleuræ increase slightly in length towards the pygidium. The whole surface of the thorax is ornamented with small tubercles of two or three different sizes, irregularly distributed.

In the Thraive Glen specimen which shows the free ends of the pleuræ, the pygidium is also partially preserved, and the two first pairs of pleuræ composing the lateral lobes are observed to have the same characters as the thoracic pleuræ, though their points are rather more strongly recurved. The third pair of pleuræ has its points almost parallel. The distinct border to the pygidium, shown in Salter's figures of the type-specimen, is not present, the marginal free points being in uninterrupted continuation of the pleuræ, and they are, moreover, of greater length than Salter indicates. In another smaller Thraive Glen specimen, the axis is well preserved and is seen to possess three well-defined rings, and a fourth less clearly marked off. In these features of the axis and of the pleuræ of the pygidium, the Girvan species agree more closely with Angelin's *L. sexspinus*[1] than with Salter's typical form of *L. laxatus*, but Törnquist[2] and Schmidt[3] consider *L. sexspinus* to be a synonym of *L. laxatus*, though the latter author points out these differences.

In the Thraive Glen specimen which possesses the thorax and pygidium, the under surface of part of the head-shield with the hypostome in position is also seen. The hypostome is large, subquadrate, with a broad flattened border having a shallow rounded notch behind and slightly swollen at the sides of the central body and in front of the posterior notch. The body is convex, arched in front, narrowing and decreasing in height posteriorly, is strongly marked off from the border laterally by wide shallow grooves and posteriorly by a weaker groove arched gently forwards. Two short oblique lateral furrows indent the body near its base. The anterior swollen part of the body is tuberculated in the same fashion as the thorax, but the posterior part behind the lateral furrows is smooth. The border has a few strong striæ parallel to the margins.

A fragmentary and poorly preserved cast of a glabella from Ardmillan in Mrs. Gray's collection, may also belong to this species. The poorly preserved specimen from Drummuck named "*Lichas*, sp. ind." by Nicholson and Etheridge (*op. cit.*) is certainly attributable to this species.

[1] Angelin, 'Pal. Scand.,' p. 74, pl. xxxviii, figs. 7, 8.

[2] Törnquist, 'Undersökn. Siljansom. Trilobitf.,' p. 31.

[3] Schmidt, 'Rev. Ostbalt. Silur. Trilob.,' pt. ii, p. 125.

Collection.—Mrs. Gray (f. M.).

Horizons and Localities.—Drummuck Group (U. Bala): Thraive Glen; Drummuck. ? Balclatchie Group (Llandeilo): Ardmillan.

7. **Lichas (Metopolichas) bulbiceps,** Phillips (?), 1873, var. Plate XIV, fig. 14.

1873. *Lichas bulbiceps,* Phillips, MS. (?), Cat. Camb. Silur. Foss. Mus. Pract. Geol., p. 39.
1896. *Lichas bulbiceps,* Reed, Quart. Journ. Geol. Soc., vol. lii, p. 428, pl. xxi, figs. 8, 8 *a*, 8 *b*, 9.
1902. *Lichas* (*Metopolichas*) *bulbiceps,* Reed, Quart. Journ. Geol. Soc., vol. lviii, pp. 73, 82.

Remarks.—There is a single cast of a nearly perfect head-shield from the Starfish Bed in Mrs. Gray's collection, which seems to belong to a variety of *L. bulbiceps,* Phillips. It agrees in all its essential characters with this species, but the first lateral furrows are connected with the occipital furrow by a strong longitudinal furrow running from the base of the bicomposite lateral lobes to the inner angle of the occipital lobes. A similar furrow is seen in some examples of the allied *L. verrucosus,* Eichw.[1] The second lateral furrows are also well-developed, and join the curved ends of the first lateral furrows, so that the bicomposite lobes are completely circumscribed by continuous furrows of uniform strength. The axial furrows outside the subquadrate fourth ("middle") lateral lobes are weak, and there is a faint arched furrow across the median lobe of the glabella connecting the bases of the bicomposite lobes.

Some of these differences in the furrows may be due to the specimen having lost its shell and being in the state of an internal cast, but I do not think they are sufficiently important to warrant our considering it as more than a variety of *L. bulbiceps.*

Collection.—Mrs. Gray.

Horizon and Locality.—Drummuck Group (U. Bala): Starfish Bed, Thraive Glen.

8. **Lichas (Metopolichas)** aff. **marginatus,** Lindström, 1885. Plate XIV, figs. 15, 16.

Remarks.—One large head-shield, 25 mm. long and 22 mm. wide between the facial sutures on the front margin, is in Mrs. Gray's collection from the Middle Llandovery of Woodland Point. Though somewhat flattened by pressure it is sufficiently well preserved and interesting to merit a special description. The glabella is about 20 mm. long, with a pair of large, oval, elongate, bicomposite lobes,

[1] Schmidt, 'Rev. Ostbalt. Silur. Trilob.,' pt. ii, p. 62, pl. ii, fig. 6.

converging posteriorly and nearly reaching back to the occipital furrow; in shape they are pointed in front but truncated at their posterior end, which is incompletely defined. The first lateral furrows are long, bend back strongly at first and converge posteriorly at about 30°, but near their extremities suddenly turn outwards and terminate blindly not far in front of the occipital furrow, into which they are continued by a shallow groove. The central lobe is narrow near the base of the bicomposite lobes, but widens anteriorly, expanding suddenly in front of them to four times its basal width, so as to completely overlap and overhang the lateral lobes.

The fourth lateral lobes are almost obsolete. A pair of occipital lobes is present; in shape they are oval, narrow, transversely elongate, and less than half the width of the neck-ring. The axial furrows are well marked and continuous, curving inwards strongly about the middle of the lateral lobes and reaching the occipital furrow nearly at the middle of the occipital lobes. The occipital furrow is strong, wide, and gently arched. The occipital ring is broad, and has a median tubercle.

The fixed cheeks consist each of (1) a convex subreniform posterior portion extending only half the length of the bicomposite lobes and having only half their width; and (2) a narrow flattened anterior wing joining the flattened striate and coarsely tuberculate frontal border of the head-shield. The eye-lobe is semicircular and prominent, with its anterior end on the axial furrow opposite the middle of the bicomposite lobe, and is separated from the convex subreniform part of the fixed cheek by a strong sigmoidal eye-furrow running back obliquely, and curving outwards posteriorly. The head-shield is ornamented with coarse, round, sub-equal and closely placed tubercles, with a few smaller round ones intermixed.

Dimensions.—

Length of head-shield . . .	25·0 mm.
Width ,, between facial sutures .	22·0 ,,
Length of glabella	20·0 ,,
Width ,, at base . . .	4·5 ,,
,, ,, at front . . .	19·0 ,,
Length of convex portion of fixed cheek . .	6·5 ,,

A large subcircular hypostome, measuring 14 mm. in length by about the same in width, is in Mrs. Gray's collection from the same horizon and locality, and probably is referable to the same species. It has a wide flattened border, swollen a little on each side behind the lateral notches, which lie just behind the small triangular anterior wings; and its posterior edge is excavated by a broad rounded notch, giving the characteristic bilobate shape. The body is subquadrate, with subparallel sides; the axial furrows are nearly straight; the posterior bounding furrow is weak, and truncates the body nearly at right angles to the axial furrows. In front the outline of the body is arched forward. The body is swollen anteriorly, but depressed behind the pair of very oblique, long, lateral

furrows. The surface of the body is coarsely punctate, but the border is striated parallel to its edge.

Affinities.—This form appears to belong to the section *Metopolichas.* The elongation of the bicomposite lobes at the expense of the fourth lateral lobes, which are almost crowded out, is noteworthy. The shape of the central lobe of the glabella, the long bicomposite lobes almost extending to the occipital furrow, the shape and size of the fixed cheeks, the position of the eyes, the tuberculate border, and the occipital furrow resemble *L. marginatus*, Lindström,[1] from the Silurian of Gotland; but the bicomposite lobes in the Girvan form are longer, and occipital lobes are also present, while in the imperfect specimens figured as the types of the Gotland species, occipital lobes seem to be wanting. The head of *L. affinis*, Angelin,[2] in these two respects bears much resemblance to the Girvan specimen. The hypostome, which I have tentatively attributed to this form, is much like that of *L. avus*, Barrande.[3]

Collection.—Mrs. Gray.

Horizon and Locality.—Saugh Hill Group (M. Llandovery): Woodland Point.

9. **Lichas (Amphilichas[4]) hibernicus** (Portlock), 1843. Plate XV, figs. 1—3.

1843. *Nuttainia hibernica*, Portlock, Geol. Rep. Londond., p. 274, pl. iv, figs. 1 *a—d*, pl. v, figs. 1—3.
— *Nuttainia hibernica*, Morris, Cat. Brit. Foss., p. 75.
1845. *Lichas hibernica*, Beyrich, Ueb. Böhm. Trilob., pp. 25, 29.
1846. *Lichas hibernica*, M'Coy, Synops. Silur. Foss. Ireland, p. 51.
1878. *Lichas* sp., Etheridge, jun., Proc. Roy. Phys. Soc. Edinb., vol. iv, p. 169.
— *Lichas hibernicus*, Nicholson and Etheridge, Mon. Silur. Foss. Girvan, fasc. i, p. 133, pl. ix, figs. 9, 10.
? 1885. *Lichas holmi*, Schmidt, Rev. Ostbalt. Silur. Trilob., pt. ii, p. 54, pl. vi, figs. 14—17.
1896. *Lichas hibernicus*, Reed, Quart. Journ. Geol. Soc., vol. lii, p. 428.
? 1902. *Lichas* (*Metalichas*) *hibernicus*, Reed, Quart. Journ. Geol. Soc., vol. lviii, p. 74, fig. 7.
— *Lichas* (*Paralichas*) *kildarensis*, Reed, ibid., p. 80.

Specific Characters.—Head-shield transversely semicircular; free cheeks unknown. Middle shield strongly convex from back to front and from side to side, bent down anteriorly. Glabella subquadrate, rounded, broader than long, strongly convex, bent down in front; composed of a median lobe and a single pair of tricomposite lateral lobes. Median lobe with independent convexity, bent down for anterior half, club-shaped, expanded transversely in front to quite twice or more

[1] Lindström, 'Förteckn. Gotl. Silur. Crust.' (Ofv. k. vet. Akad. Förhandl., No. 6 [1885]), p. 58, pl. xiv, figs. 8, 9.

[2] Angelin, 'Pal. Scand.,' p. 69, pl. xxxviii, fig. 4; Törnquist, 'Undersökn. Siljans. Trilobit.,' p. 33, pl. i, fig. 31.

[3] Barrande, 'Syst. Silur. Bohême,' vol. i, Suppl., pl. vi, fig. 25; pl. x, fig. 14.

[4] The name *Amphilichas* has been proposed by Raymond ('Amer. Journ. Sci.,' vol. xix, 1905, p. 378) in place of *Paralichas*, the latter being pre-occupied.

than twice its basal width; anterior outline arched; anterior lateral angles pointed at about 45° and overhanging inner half of lateral lobes; posterior half of median lobe with nearly parallel sides and less convex. First lateral furrows strong, deep, curving strongly inwards at first to about middle of median lobe, thence running back almost parallel and straight to meet occipital furrow at right angles. Lateral lobes tricomposite, suboval, elongate, more than twice as long as wide, pointed in front, truncated obliquely behind, gently convex, less elevated than median lobe; of nearly uniform width for more than two thirds of their length, then rapidly narrowing to pointed anterior extremity; extending about four fifths the length of the glabella, and of less width than median lobe at base; strongly bent down with general curvature of head-shield at about half their length. Axial furrows deep, equal in strength to first lateral furrows, strongly curved, nearly parallel to axial furrows, concave outwards as far as front end of lateral lobes, round which they bend inwards to meet first lateral furrows at anterior lateral angles of glabella, and pass into marginal furrow. Marginal furrow marking off very narrow rounded border on anterior margin in front of glabella.

Occipital furrow straight and horizontal behind median lobe, and at right angles to first lateral furrows, outside of which it is directed obliquely backwards behind lateral lobes. Occipital ring broadest behind median lobe, where it is of uniform width, but behind lateral lobes it decreases in width. Occipital lobes completely absent.

Fixed cheeks with narrow band-like flattened anterior wing alongside lateral lobes; posterior wing broad, triangular, gently convex. Neck-segment widening laterally, marked off by strong furrow. Facial suture cutting anterior margin just above lateral angles of glabella, thence curving outwards back to eye-lobe which it encircles, behind which it runs outwards and backwards in a weakly sigmoidal curve to cut posterior margin at about 60° at a distance from the axial furrow equal to about one third the width of the glabella. Eye-lobe situated opposite middle of lateral lobe where the downward curvature commences; of moderate size, rounded, semicircular, with eye-furrow near base. Surface of glabella, occipital ring and cheeks covered with closely-set low round hollow tubercles varying somewhat in size and prominence.

Remarks.—There has never been any adequate description of the head-shield called *L. hibernicus*, Portlock's original account being insufficient, and that given by Nicholson and Etheridge (*op. cit.*) being scarcely full enough for all purposes. The above description, therefore, based on the specimens used by Portlock and on other examples from the typical locality, Kildare, may be advantageous. The Girvan specimens agree with this diagnosis of *L. hibernicus* in all particulars so far as they are preserved. Schmidt[1] was of the opinion that his *L. holmi* was probably identical, but of this I cannot feel certain.

[1] Schmidt, 'Rev. Ostbalt. Silur. Trilob.,' pt. ii (1885), p. 54, pl. vi, figs. 14—17.

It has been thought that the head-shields which were attributed to *L. hibernicus* by Portlock and others should be separated off from the pygidium and thorax forming the original type of *L. hibernicus* (Portlock, *op. cit.*, pl. iv, fig. 1 *c*), and that quite a different type of pygidium should be associated with them. The reasons for this view were first brought forward by Schmidt (*op. cit.*, p. 29), and more recently were referred to by the author (*op. cit.*). The character of the ornamentation in the Irish forms seems to support this view. But this splitting up of an old-established species may be considered of somewhat doubtful wisdom till we have had our suspicions confirmed by a complete individual showing both the head-shield and pygidium in connection.

Head-shields of the type usually called *L. hibernicus* occur at Craighead, but no pygidia are known. From Balclatchie, however, in the Edinburgh Museum there is a pygidium resembling Portlock's type, and agreeing in style of ornamentation with the head-shields which Schmidt would separate off, and which occur in the same locality. No other species of *Lichas* (save one poorly-preserved specimen of a peculiar head-shield (p. 110), specifically indeterminable, from the Balclatchie conglomerate) is known from this locality, so the natural presumption is that this pygidium belongs to the same species as the head-shields named *L. hibernicus.* It does not entirely agree with Portlock's type, as it shows two complete rings on the axis and a third ring incomplete in the middle; but the pleuræ are similar, only the first two pairs having furrows, and their extremities are not preserved; and the post-axial piece has precisely the same general characters. It may indicate a variety of the species.

There is a hypostome from Balclatchie in Mrs. Gray's collection which may probably be referred to *L. hibernicus.* Its description is as follows:—Body subcircular, a little broader than long, convex, with sides marked by a pair of strong short horizontal lateral furrows at about one third the distance from posterior end. From the inner end of these furrows two short narrow ridges run obliquely backwards and inwards. Axial furrows deep, strong. Border in front of body narrow, prolonged laterally into upwardly directed pointed wings, behind which it becomes strongly swollen and excavated opposite the lateral furrows of the body. Behind these furrows the border rapidly widens, becomes flattened, and is produced laterally into a second pair of pointed wings directed upwards. Behind the body the border is produced into a pair of rounded flattened approximate lobes. Some faint concentric striæ ornament the sides of the body and the border.

Dimensions of hypostome.—

Length	. 12·0 mm.
,, of body . . .	. 8·0 ,,
Width of ,, . . .	. 10·0 ,,

Collections.—Mrs. Gray; Museum of Practical Geology; Edinburgh Museum.

Horizons and Localities.—Stinchar Limestone Group (Llandeilo): Craighead. ? Balclatchie Group (Llandeilo): Balclatchie.

10. **Lichas (Amphilichas)** sp. ind. Plate XV, figs. 4, 5.

Remarks.—There are some fragments of a large head-shield from Dow Hill which, though belonging to the same group and sub-genus as *L. hibernicus*, are probably specifically distinct. The long bicomposite lobes converge more inwards posteriorly, so that the neck of the median lobe has not its sides so nearly parallel. Moreover, the first lateral furrows, in addition to their more marked convergence, are not continued back to the neck-ring with uniform strength, but almost die out a little behind the middle of the lateral lobes, being represented posteriorly by only faint and shallow depressions on the surface. The occipital segment and the other features appear to be identical with *L. hibernicus*.

A portion of a very strongly tuberculated thoracic segment with the pleura showing a somewhat irregular diagonal furrow, behind which lie some 2—3 specially large, rounded, prominent tubercles, elevated above the general tuberculated surface, may belong to the same species.

L. lævis, Eichwald,[1] is a species belonging to *Amphilichas* which has similar incomplete first lateral furrows; but I know of no other allied species.

Collection.—Mrs. Gray.

Horizon and Locality.—Balclatchie Group (Llandeilo): Dow Hill.

11. **Lichas (Conolichas)** cf. **æquiloba,** Steinhardt, 1874. Plate XV, fig. 6.

1874. *Lichas æquiloba*, Steinhardt, Preuss. Geschieb. Gefund. Trilob., p. 31, pl. iii, fig. 6.
1877. *Conolichas æquiloba*, Dames, Zeitschr. deutsch. geol. Gesell., p. 807, pl. xiii, fig. 5.
1886. *Lichas æquiloba*, Schmidt, Rev. Ostbalt. Silur. Trilob., pt. ii, p. 89, pl. v, figs. 4—10.
1890. *Lichas æquiloba*, Pompecki, Trilobitf. Ost.-West. Preuss. Diluv. Geschieb., p. 48, pl. v, fig. 14.
1901. *Lichas æquiloba*, Gürich, Neues Jahrb. f. Min., Beil. Bd. xiv, p. 519.
1902. *Lichas* (*Conolichas*) *æquiloba*, Reed, Quart. Journ. Geol. Soc., vol. lviii, pp. 61, 79, figs. 15 *a, b*.

Remarks.—There is one small incomplete head-shield from the Starfish bed in Mrs. Gray's collection which shows the peculiar features of *L. æquiloba*, Steinh. (*op. cit.*), so far as it is preserved. There is the characteristic suddenly swollen and elevated anterior portion of the central lobe of the glabella with the long, narrow, depressed neck between the elongated, oval, tricomposite lobes. The whole glabella is coarsely but scantily tuberculated; it measures only 4 mm. in

[1] Schmidt, *op. cit.*, p. 49, pl. vi, figs. 5—10.

length and the same in width. The rest of the head-shield is not preserved, but the features of the glabella are sufficient to show that it belongs to the peculiar section or sub-genus of *Lichas* known as *Conolichas*,[1] which has not hitherto been recorded from Britain.

Collection.—Mrs. Gray.

Horizon and Locality.—Drummuck Group (U. Bala): Starfish Bed, Thraive Glen.

12. **Lichas,** sp. ind. Plate XV, fig. 7.

Description.—A minute head-shield, only 3 mm. long, from Balclatchie, shows certain peculiar features. It is tumid, strongly convex from side to side and from back to front. The glabella rises steeply from the neck-ring, and has a central lobe which gradually and slowly expands towards the front, but does not much overhang the lateral lobes, which are bicomposite, broadly oval, rounded at both ends, as wide as the central lobe, and three fourths the total length of the glabella, nearly reaching the neck-ring. They are completely circumscribed by furrows, except at the base, and have a distinct notch on their inner side. The first lateral furrows converge posteriorly at an angle of about 30°, are very slightly arched inwards, bending outwards at their posterior end to terminate suddenly behind the lateral lobes. The neck-furrow is well marked, and separates off a rounded occipital segment. The specimen is not well enough preserved to show if the fourth lateral lobes are defined, or if occipital lobes are present. A narrow, flattened, smooth border surrounds the front end of the head; and a few large scattered tubercles are visible on the glabella.

Collection.—Mrs. Gray.

Horizon and Locality.—Balclatchie Group (Llandeilo): Balclatchie.

Genus **LICHAPYGE,** Callaway.

1. **Lichapyge? problematica,** sp. nov. Plate XV, figs. 8—10.

1880. *Dionide ?* sp. ind. *c*, Nicholson and Etheridge, Mon. Silur. Foss. Girvan, fasc. iii, p. 295, pl. xx, fig. 4.

Specific Characters.—Pygidium semi-elliptical to subquadrate, flattened. Axis weakly convex, conical, about half the length of the pygidium and one third its width at front end; consisting of 6—7 rings, of which only the first four are distinct and bear a faint median tubercle. From the extremity of the axis extends a

[1] Reed, 'Quart. Journ. Geol. Soc.,' vol. lviii (1902), p. 78.

narrow, straight, post-axial ridge to the posterior margin. Lateral lobes horizontally extended, consisting of 6—7 pairs of pleuræ, each with a well-marked diagonal furrow. The first three pairs of pleuræ are straight and horizontal, and end in short, tapering, free spines, projecting beyond the margin and bent backwards. The fourth pair of pleuræ is similar, but is produced into long, nearly straight spines projecting freely backwards to some little distance behind the pygidium. Behind this pair the pleuræ are successively curved more strongly backwards till they lie almost parallel to the post-axial ridge, but they have no free points, and die out shortly before reaching the regular rounded simple margin. The last pair of pleuræ is indistinct.

Dimensions.—

Length	2·5 mm.
Width	2·0 ,,

Remarks.—The original specimen belonging to this species, which Nicholson and Etheridge (*op. cit.*) figured and described as "*Dionide?* sp. ind." was imperfect, for it lacked the marginal portion of the pygidium, which is now known to be spinose. It is by means of the recently obtained material in Mrs. Gray's collection from the original locality, Whitehouse Bay, that I am able to give the above fuller and more accurate description of this peculiar form. Unluckily the pygidia are always found detached, and the head and thorax of this interesting trilobite are completely unknown. The true generic position of this curious pygidium is uncertain, but there does not seem to be any reason for assigning it to the genus *Dionide.* The only genus which has somewhat similar characters is *Lichapyge*,[1] and this agrees in the triangular conical axis of few rings with a narrow ridge reaching to the margin, and the anterior pairs of grooved pleuræ ending freely in spines on the margin, while the posterior ones end within it. The only two species which appear to have been described as belonging to this genus are *L. primula*, Barr.,[2] from the Leimnitz beds of Hof, and *L. cuspidata*, Call. (*op. cit.*), from the Shineton Shales of Shropshire. Both of these differ in having only two pairs of pleuræ with free extremities, and in having the posterior pleuræ very ill-defined. But in spite of these differences it seems better to associate this Girvan form with this genus rather than with any other which has been described.

Collection.—Mrs. Gray (f. M.).

Horizon and Locality.—Whitehouse Group (M. Bala) : Whitehouse Bay.

[1] Callaway, 'Quart. Journ. Geol. Soc.,' vol. xxxiv (1877), p. 667, pl. xx, fig. 8; Linnarsson, 'Geol. Mag.' [2], vol. v (1878), p. 188.

[2] Barrande, 'Neues Jahrb. f. Min., etc.' (1868), p. 679, fig. 34; Gümbel, 'Geogn. Beschr. Kön. Bayern,' vol. ii (1879), p. 439, fig. 7.

Genus **ACIDASPIS,** Murchison.

1. **Acidaspis barrandei,** Fletcher and Salter, 1853. Plate XV, fig. 11.

1848. *Acidaspis bispinosus,* Salter, *e. p.* Mem. Geol. Surv., vol. ii, pt. i, pl. ix, fig. 4 only.
1853. *Acidaspis barrandii,* Fletcher (*dixit* Salter), Mem. Geol. Surv., dec. vii, p. 6, pl. vi.
1854. *Acidaspis barrandii,* Morris, Cat. Brit. Foss, 2nd ed., p. 98.
1859. *Acidaspis barrandii,* Murchison, Siluria, 3rd ed., p. 261, foss. 64, fig. 9.
1890. *Ceratocephala barrandei,* Clarke, 44th Rep. New York State Museum, p. 93.
1896. *Acidaspis barrandei,* Lake, Quart. Journ. Geol. Soc., vol. lii, p. 241, pl. viii, figs. 1—3.

Remarks.—One fine head-shield with the two pairs of posterior spines well preserved, and another less perfect one, both from Penkill, represent this species in Mrs. Gray's collection. Mr. Lake's full and recent description (*op. cit.*) renders further remarks needless. Clarke (*op. cit.*) is desirous of substituting Warder's[1] earlier name *Ceratocephala* for the whole genus usually termed *Acidaspis*, and of using it in a stricter sense to designate a subdivision of the genus. But the name is usually rejected because the name *Ceratocephalus* had been previously applied by De Candolle to a genus of plants.

Collection.—Mrs. Gray.

Horizon and Locality.—Penkill Group (Tarannon = part of Mrs. Gray's U. Llandovery): Penkill.

Acidaspis callipareos, Wyville Thomson, 1857. Plate XV, figs. 12, 13.

1857. *Acidaspis callipareos,* Wyville Thomson, Quart. Journ. Geol. Soc., vol. xiii, p. 208, pl. vi, figs. 11, 12.
? 1857. *Acidaspis hystrix,* Wyville Thomson (*e. p.*), ibid., pl. vi, figs. 7, 8 (*non* figs. 6, 9, 10).
1876. *Acidaspis callipareos,* Armstrong and Young, Cat. West. Scot. Foss., p. 15.
1877. *Acidaspis callipareos,* Woodward, Cat. Brit. Foss. Crust., p. 18.
1878. *Acidaspis callipareos,* Nicholson and Etheridge, Mon. Silur. Foss. Girvan, fasc. i, p. 125.
1896. *Acidaspis callipareos,* Lake, Quart. Journ. Geol. Soc., vol. lii, p. 243.

Remarks.—The typical locality for this species is Mulloch Hill. It was founded on a head-shield, but it is probable that the thorax described and figured by Wyville Thomson from Rough Neuk, Mulloch Hill, as belonging to *A. hystrix*, really should be attributed to *A. callipareos*, for *A. hystrix* typically comes from the Balclatchie (Llandeilo) beds. Nicholson and Etheridge (*op. cit.*) were also inclined to hold this view. In Mrs. Gray's collection two imperfect head-shields, one with a few body-rings attached, from Woodland Point, appear to be attributable to this species, and perhaps a body-ring from Newlands also belongs to it.

[1] Warder, 'Amer. Journ. Sci.,' vol. xxxiv (1838), p. 377.

Collection.—Mrs. Gray.

Horizon and Locality.—Mulloch Hill Group (L. Llandovery): (typ.) Mulloch Hill; Newlands. Saugh Hill Group (M. Llandovery): Woodland Point.

3. **Acidaspis coronata,** Salter, 1853. Plate XV, fig. 14.

? 1839. *Paradoxides quadrimucronatus,* Murchison, Silur. Syst., p. 658, pl. xiv, fig. 10.
? 1845. *Odontopleura mutica,* Emmrich, Neues Jahrb., p. 44.
? 1846. *Odontopleura mutica,* Beyrich, Untersuch. üb. Trilob., p. 19, pl. iii, fig. 5.
1848. *Acidaspis brightii,* Salter (*e. p.*), Mem. Geol. Surv., vol. ii, pt. i, p. 348, pl. ix, figs. 8, 9 (*non* figs. 6, 7).
1853. *Acidaspis coronatus,* Salter, Mem. Geol. Surv., dec. vii, pl. vi, p. 7.
1854. *Acidaspis coronatus,* Morris, Cat. Brit. Foss., 2nd ed., p. 99.
— *Acidaspis marklini,* Angelin, Pal. Scand., p. 38, pl. xxii, fig. 13.
— *Acidaspis multicuspis,* Angelin, ibid., p. 37, pl. xxii, fig. 12.
1857. *Acidaspis coronata,* Salter, Quart. Journ. Geol. Soc., vol. xiii, p. 210.
1877. *Acidaspis coronata,* Woodward, Cat. Brit. Foss. Crust., p. 18.
1885. *Acidaspis marklini,* Lindström, Förteckn. Gotl. Silur. Crust., Ofv. k. vet. Akad. Förhandl., No. 6, p. 54, pl. xiii, figs. 8, 15; pl. xvi, fig. 10.
1888. *Acidaspis mutica,* Wigand, Zeitschr. deutsch. geol. Gesell., vol. xl, p. 93, pl. x, figs. 19, 20.
? 1879. *Acidaspis?* sp. ind., Nicholson and Etheridge, Mon. Silur. Foss. Girvan, fasc. ii, p. 206, pl. xiv, fig. 14.
1896. *Acidaspis coronata,* Lake, Quart. Journ. Geol. Soc., vol. lii, p. 237, pl. vii, fig. 6.
1899. *Acidaspis brighti,* Mem. Geol. Surv., Silur. Rocks Brit., vol. i, Scotland, pp. 543, 688.

Remarks.—This species is well represented by good pygidia from Woodland Point in Mrs. Gray's collection, and there is one specimen from Mulloch Hill. The identity of this species with *A. marklini*, Lindström, from the Silurian of Gotland has been noticed by Mr. Lake. The poor specimen of an *Acidaspis* from Bargany Pond figured by Nicholson and Etheridge (*op. cit.*) as "*Acidaspis ?* sp. ind.," probably belongs to this species.

Collections.—Mrs. Gray; Edinburgh Museum (f. M.).

Horizons and Localities.—Mulloch Hill Group (L. Llandovery): Mulloch Hill. Saugh Hill Group (M. Llandovery): Woodland Point. Camregan Group (U. Llandovery): Bargany Pond Burn.

4. **Acidaspis deflexa,** Lake, 1896. Plate XV, fig. 15.

1879. *Acidaspis,* sp., Nicholson and Etheridge, Mon. Silur. Foss. Girvan, fasc. ii, p. 129, woodcut, fig. 7 *c*.
1896. *Acidaspis deflexa,* Lake, Quart. Journ. Geol. Soc., vol. lii, p. 239, pl. vii, fig. 7.

Remarks.—The imperfect pygidium figured by Nicholson and Etheridge (*op. cit.*) from Mulloch Hill as "*Acidaspis* sp." may without much doubt be referred to Mr. Lake's species, *A. deflexa*. The woodcut given by them is misleading, for the second pair of spines are almost parallel and do not curve inwards as there indicated.

The species is also represented in Mrs. Gray's collection by several nearly complete specimens from the same locality. The pygidia have the first pair of spines rather more developed than in Mr. Lake's type-specimen, but he agrees with me that these Girvan specimens are referable to *A. deflexa*.

Collections.—Mrs. Gray (f. M.): Woodwardian [Sedgwick] Museum.

Horizon and Locality.—Mulloch Hill Group (L. Llandovery): Rough Neuk; Mulloch Hill.

5. **Acidaspis grayæ**, Etheridge, jun., 1878. Plate XV, figs. 16—18; Plate XVI, figs. 1, 2.

1878. *Acidaspis grayæ*, Etheridge, jun., Proc. Roy. Phys. Soc. Edinb., vol. iv, p. 170, pl. ii, figs. 6–8.

1878. *Acidaspis grayæ*, Nicholson and Etheridge, Mon. Silur. Foss. Girvan, fasc. i, p. 126, pl. viii, fig. 26; pl. ix, figs. 1—7, and p. 129, fig. 7 B.

? 1878. *Acidaspis lalage*, Nicholson and Etheridge (*e. p.*), ibid., pl. viii, figs. 18, 19 (*non* figs. 17, 20—22).

1899. *Acidaspis grayæ*, Mem. Geol. Surv., Silur. Rocks Brit., vol. i, Scotland, pp. 509, 671, 688.

Specific Characters.—General form oval, depressed.

Head-shield sub-semicircular, rather flattened in front. Glabella convex, parabolic, broadest behind. Lateral lobes imperfectly known owing to bad preservation of type, but apparently three pairs are present; anterior pair mere nodules; second pair round; third pair elongate, oval; all circumscribed completely and separate; central lobe cylindrical. Occipital ring very broad, projecting posteriorly, marked off from central lobe of glabella by wide shallow furrow. Occipital lobes narrow, oblique (as in *A. lalage*, q. v.). Fixed cheeks triangular, swollen, separated from glabella by deep axial furrows. Eye-ridge running outwards from anterior end of glabella to eye, curved, rounded, narrow, broadening posteriorly. Eye small, distant from axial furrow about half (?) width of glabella, and situated opposite middle of glabella. Free cheek with smooth narrow lateral border armed with about 14 radiating spines decreasing in length anteriorly. Genal angle furnished with long curved spine, extending about three fourths the length of the thorax. Surface of head-shield covered with minute tubercles, somewhat scattered.

Thorax of ten segments. Axis narrow, convex, prominent, sub-cylindrical, tapering a little to pygidium; about one fourth the width of thorax; axial rings with obscure lateral swellings. Pleuræ straight, horizontally extended, with broad nearly median longitudinal groove, bordered by narrow rounded elevated margins,

of which the posterior one is the stronger. Surface of pleuræ minutely pitted, and borders ornamented with single row of minute tubercles. At extremity of each pleura are three spines; (1) the bordering ridges unite and are produced into a long median straight or gently curved spine directed backwards, and armed with minute denticles on its anterior and posterior edges. In front of this median spine there projects (2) a very small blunt spine, and behind the former is likewise (3) a short spine, stouter than the anterior one.

Pygidium very broadly semicircular, about three times as wide as long (not including spines), flattened, horizontally extended, with narrow, smooth, raised lateral border bearing spines, and narrower raised border on straight anterior edge. Axis convex, conical, prominent, about one fourth the width of the pygidium, and composed of two segments and a half ring on front end for articulation. The first segment is a regular prominent ring, tuberculate and defined behind by a strong furrow; the second segment (which may be of composite origin) is longer and larger, subquadrate or bluntly subtriangular in shape and tuberculate, with an obscure ring on its anterior part defined by a pair of pits behind it. Lateral lobes flattened; surface reticulate and traversed by a curved ridge arising from the first axial segment and ending on the border at the base of the sixth pair of spines. Border of pygidium narrow, smooth, raised, and furnished with eight pairs of spines, radiating, straight, and of equal length, those of the posterior pair being parallel. The spines are armed with minute lateral denticles, alternate on opposite sides of the same spine and sub-alternate on opposite sides of adjacent spines.

Remarks.—The three species *Acidaspis grayæ*, *A. hystrix*, and *A lalage* are found associated in the same bed and in the same locality, and are undoubtedly closely allied. In fact I have much doubt whether *A. grayæ* is really separable from *A. lalage*, but the material at present available is not sufficient to decide this point. The type of *A. grayæ* is in Mrs. Gray's collection, and is in a poor state of preservation, but it consists of an entire individual, which is satisfactory, as we have generally to deal with detached heads and pygidia. In this type-specimen the head is badly preserved, and the spines on the margin of the pygidium are broken off short, but the other specimens of the pygidium have the spines attached and the denticles preserved. As Nicholson and Etheridge remark, the distinction from *A. lalage* seems to consist chiefly in the denticulated spines, for the head-shield is too poorly preserved to make a minute comparison. As far, however, as its characters can be made out, it has similar proportions, the lobation of the glabella agrees, the occipital lobes are developed in the same manner, and the occipital ring has the same relative dimensions, but it is apparently devoid of the pair of long diverging spines, so conspicuous in *A. lalage*. Etheridge was wrong in the statement that the pygidium had only fifteen spines, for the bases of sixteen can be counted on his type-specimen figured in the 'Proceedings of the Royal Physical

Society of Edinburgh' (*loc. cit.*), and eight pairs of well-developed denticulated spines can be easily recognised in the other figured specimens (Etheridge, *op. cit.*, pl. ii, figs. 7, 8). In *A. lalage*, Wyville Thomson[1] described twelve to fourteen lateral spines on the pygidium, but in one of his figures (fig. 4*b*) he shows nine distinct pairs. In all the examples of *A. grayæ* there are always two pairs of spines posterior to those to which the pleural ridges run.

Collections.—Mrs. Gray (f. M.); Edinburgh Museum; Hunterian Museum.

Horizon and Locality.—Balclatchie Group (Llandeilo): Balclatchie.

6. **Acidaspis hystrix**, Wyville Thomson, 1857. Plate XVI, figs. 3—5.

1857. *Acidaspis hystrix*, Wyville Thomson (*e.p.*), Quart. Journ. Geol. Soc., vol. xiii, p. 207, pl. vi, figs. 6, 9, 10 (*non* figs. 7, 8).

1876. *Acidaspis hystrix*, Armstrong and Young, Cat. West. Scot. Foss., p. 15.

1877. *Acidaspis hystrix*, Woodward, Cat. Brit. Foss. Crust., p. 19.

1878. *Acidaspis hystrix*, Nicholson and Etheridge, Mon. Silur. Foss. Girvan, fasc. i, p. 123, pl. viii, figs. 23—25.

1878. *Acidaspis lalage*, Nicholson and Etheridge (*e.p.*), ibid., pl. viii, fig. 17 (*non cet.*).

1899. *Acidaspis hystrix*, Mem. Geol. Surv., Silur. Rocks Brit., vol. i, Scotland, pp. 509, 672, 688.

Specific Characters.—"Less than half an inch long. Glabella broadly triangular, not very highly arched; middle lobe rather narrow; lateral lobes two, oval, separated by distinct grooves from the central lobe and from the cheek; basal lateral lobe fused with the neck-segment. Portion of cheek within the facial suture very gibbous, likewise confluent with the neck-segment. Neck-segment very prominent, separated from the middle lobe of the glabella by a shallow groove. . . . Head densely ornamented with tubercles. Axis of thorax and abdomen narrow and prominent. Body-rings nine; lateral portion of body-ring horizontal, convex, with a groove running along it somewhat nearer the anterior than the posterior margin, and dividing the surface into a narrower anterior and a broader posterior ridge, the posterior ridge terminating in an abruptly reflexed, slightly curved spine, nearly one third the length of the body, and the anterior in a smaller spine, less abruptly reflexed and so placed as to pass below the posterior spine of the segment before it. Tail minute, short, and as wide as the body-rings; axis of two very convex segments, margin fringed with twelve [fourteen] parallel or slightly approximate equal spines. A ridge runs from the first axis-segment on either side continuous with the antepenultimate spine, indicating the primary spine, the posterior spine of the anterior tail-segment. The surface of the body-rings and tail is richly granular." (*Wyville Thomson.*)

[1] 'Quart. Journ. Geol. Soc.,' vol. xiii (1857), p. 206, pl. vi, figs. 1—5.

Remarks.—There is not much to add to this description. The characters of the head-shield sufficiently distinguish it from *A. lalage.* The anterior and posterior ridges of the pleuræ of the thorax bear a single row of relatively large coarse tubercles; and in the pygidium the second axial segment is longer than the first ring, and of a subquadrate shape. The axis is about one fourth to one fifth the width of the pygidium. There is no distinct border, and the surface is coarsely tuberculated up to the bases of the spines, which are fourteen in number. In the thorax the axis is about one fifth the width of the whole body, being therefore narrower than in *A. grayæ* and *A. lalage.*

The specimen attributed to *A. lalage* by Nicholson and Etheridge (*op. cit.*, pl. viii, fig. 17) consists of a thorax with the axis and pleuræ possessing the essential characters of *A. hystrix;* the position and size of the pleural groove and of the bounding ridges, the character of their ornamentation, and the size and relation of the distal spines agree precisely. It is unfortunate that the head-shield is not better preserved. The figures given by Nicholson and Etheridge leave something to be desired.

Collections.—Mrs. Gray (f. M.); Museum of Practical Geology; Edinburgh Museum.

Horizon and Localities.—Balclatchie Group (Llandeilo): Balclatchie; Penwhapple Glen.

7. **Acidaspis lalage,** Wyville Thomson, 1857. Plate XVI, fig. 6.

1857. *Acidaspis lalage,* Wyville Thomson, Quart. Journ. Geol. Soc., vol. xiii, p. 206, pl. vi, figs. 1—5.
1876. *Acidaspis lalage,* Armstrong and Young, Cat. West. Scot. Foss., p. 15.
1877. *Acidaspis lalage,* Woodward, Cat. Brit. Foss. Crust., p. 19.
1878. *Acidaspis lalage,* Nicholson and Etheridge (*e. p.*), Mon. Silur. Foss. Girvan, fasc. i, p. 121, pl. viii, figs. 20, 21, 22 (*non* figs. 17, 18, 19).
1899. *Acidaspis lalage,* Mem. Geol. Surv., Silur. Rocks Brit., vol. i, Scotland, pp. 510, 688.

Specific Characters.—"Not above half an inch long. General form broad, rather square. Head broad and short. Glabella triangular; median lobe broad, not very prominent. Two oval side lobes entirely circumscribed, separated from the median lobe by distinct furrows. Portion of the cheek within the facial suture very gibbous. Ocular ridge distinct. Eyes somewhat remote. Neck-segment separated from the median lobe of the glabella by a shallow groove; gibbous, and continued backward into two long, diverging, straight, or curved spines. Axis of thorax and abdomen narrow, prominent. Body-rings nine; lateral portions horizontal, convex; a longitudinal furrow separates the convexity into two ridges, which coalesce at the distal extremity, and end in a long, slightly recurved spine.

Tail, short, semicircular, of two short segments fringed with from twelve to fourteen long, radiating equal spines; a ridge from the anterior axis-segment is continuous with the antepenultimate [?] spine on either side. General surface of the head and body-rings slightly tubercular; surface of tail reticulated." (*Wyville Thomson.*)

Remarks.—A few more details may be added to the description of the head-shield, the good specimens in Mrs. Gray's collection showing some additional features; for Wyville Thomson had not very well preserved material for figuring, and in none of his figures is the posterior part of the head-shield well shown. Nicholson and Etheridge (*op. cit.*) also failed to represent it correctly, as an examination of their type-specimens proves, and moreover they figured as belonging to *A. lalage* two head-shields (*op. cit.*, pl. viii, figs. 18, 19) which must be assigned to other species; only three of the specimens figured by them (*op. cit.*, pl. viii, figs. 20—22) can be left in *A. lalage*, if we keep strictly to Wyville Thomson's definition. The specimen figured by them in fig. 21 is in excellent preservation. In this head-shield the anterior end of the median lobe of the glabella expands, so as to overhang the anterior pair of lateral lobes, and these lateral angles of the median lobe are slightly nodular and notched behind so as to appear like a pair of small lateral lobes (as in true homology they are). The lobes of the so-called anterior or first lateral pair are subcircular and completely circumscribed; those of the second pair are oval, longer, and also completely circumscribed. Behind them are narrow, depressed, oblique occipital lobes, formed by the narrowed lateral portions of the occipital ring; these pseudo-occipital lobes are marked off from the gibbous fixed cheek by the continuation of the axial furrows, and from the broad median part of the occipital ring by the continuation of the united furrows which mark off the lateral lobes from the median lobe of the glabella. The shallow, broad occipital groove is far forward, being nearly opposite the middle of the second pair of lateral lobes. The median lobe of the glabella in front of it is broader than the lateral lobes, and cylindrical in shape, but narrows slightly anteriorly. The occipital ring is so enlarged as to be more than one third the length of the glabella, and it bears a median tubercle as well as the pair of long divergent posterior spines. These features are well shown (except the occipital lobes) in Wyville Thomson's figure 3, pl. vi (*op. cit.*). The axial furrows curve outwards and run obliquely backwards in such a way as to give the glabella a hyperbolic rather than triangular shape. The fixed cheeks are swollen to nearly the same extent as the glabella, and are sharply marked off from it by the deep axial furrows; a narrow, rounded, swollen neck-segment is separated off by a deep neck furrow widening laterally. The eye-ridge curves outward from the anterior end of the glabella to reach the eye, which is small and situated opposite the middle of the second lateral lobes of the glabella, and distant less than half the width of the glabella at this level from the axial furrow. The anterior margin of the middle shield is nearly straight, and is

furnished with a narrow rounded border. The surface of the fixed cheeks is reticulated as well as tuberculated.

The thorax of this species as figured and described by Wyville Thomson (*op. cit.*, pl. vi, figs. 4 *a*, 5) agrees closely with that belonging to the type of *A. grayæ*, for the type of this species luckily consists of an entire individual. But the pleural spines are not denticulate, and the supplementary marginal spines seem to be absent. The pygidium also bears a very close resemblance to this species, except in the number of the marginal spines and their want of denticulations. Specimens showing the above characters are in Mrs. Gray's collection. As already stated, I have some doubt whether the species *A. lalage* and *A. grayæ* are truly distinct. At any rate the thorax, with an imperfect head-shield attached, which Nicholson and Etheridge figured as belonging to *A. lalage* (*op. cit.*, pl. viii, fig. 17) is completely different to that figured by Wyville Thomson; the pleural groove is much narrower and further forward, the ridge bounding it behind is much stronger than the anterior marginal one; the long lateral spine is in direct continuation of the main ridge, and the anterior ridge is furnished with a short straight spine projecting horizontally. Both ridges are also ornamented with a row of 7—9 tubercles. It should probably be referred to *A. hystrix* (*q.v.*) The true thorax and pygidium of *A. lalage* may still remain to be discovered, unless *A. grayæ* proves to be identical.

Collections.—Mrs. Gray (f. M.); Edinburgh Museum.

Horizon and Localities.—Balclatchie Group (Llandeilo): Balclatchie; Dow Hill.

8. **Acidaspis dalecarlica,** Törnquist, 1884. ? Plate XVI, fig. 7.

1884. *Acidaspis dalecarlica,* Törnquist, Siljansom. Trilobitf. (Sver. Geol. Undersökn., ser. C, No. 66) p. 27, pl. i, fig. 23.

A small pygidium, about 5 mm. wide, from Shalloch Mill is probably identical with Törnquist's species *A. dalecarlica* (*op. cit.*) from the Trinucleus Shales of Sweden. It is distinct from any British form hitherto described.

Description.—Pygidium flattened, transverse, nearly twice as broad as long (including spines), with strong rounded ridge on front margin. Axis short, wide, of two rings. Lateral lobes small, depressed, traversed by one strong pair of ridges which are continued into the third pair of spines; border raised and furnished with six pairs of spines, of which the first two pairs are equidistant, straight, subequal, projecting backwards and slightly outwards; the third pair is larger, stouter, and longer than any of the others, and is produced backwards to about twice the length of the second pair; the fourth pair is small and partly overlapped by the third pair.

and the two inner pairs are shorter, equidistant, and subequal, the inner spines being parallel, and the outer slightly divergent. Whole surface of pygidium and spines covered with small, sharp tubercles and granules.

Remarks.—This Girvan specimen only appears to differ from the Swedish species by having the three inner pairs of spines a little longer. In *A. caractaci*, Salter,[1] from the Bala of Shropshire there is the same number of spines, but the third pair does not overlap the fourth pair.

Collection.—Mrs. Gray.

Horizon and Locality.—Whitehouse Group (M. Bala) : Shalloch Mill.

Family ENCRINURIDÆ.

Genus **ENCRINURUS,** Emmrich.

1. **Encrinurus punctatus** (Brünnich), 1781. Plate XVI, fig. 8.

1759. *Entomolithus paradoxus*, Linnæus, Act. Reg. Acad. Sci. Holm., p. 22, pl. i, fig. 2.
1781. *Trilobus punctatus*, Brünnich, Köjbenh. Sellsk. Skrivt. nye Samml., i, p. 394.
1821. *Entomostracites punctata*, Wahlenberg, Act. Soc. Sci. Ups., vol. viii, p. 32, pl. ii, fig. 1 (tail only).
1822. *Calymene variolaris*, Brongniart, Crust. Foss., pl. i, fig. 3 A (non B).
1826. *Calymene punctata*, Dalman, Palæad., p. 47, pl. ii, figs. 2 *a*, *b*.
1836. *Asaphus tuberculatus*, Buckland, Geol. and Mineral. (Bridgw. Treat.), pl. xlvi, fig. 6.
1837. *Calymene punctata*, Hisinger, Leth. Suec., pl. i, fig. 9.
1839. *Calymene punctata*, Murchison, Silur. Syst., p. 650, pl. xxiii, fig. 8.
? 1839. *Phacops variolaris*, Emmrich, Dissert., p. 20.
1845. *Encrinurus punctatus*, Emmrich, Neues Jahrb., p. 42.
1846. *Encrinurus stokesii*, M'Coy, Synops. Silur. Foss. Ireland, p. 46, pl. iv, fig. 15.
1847. *Encrinurus punctatus*, Corda, Prodr. Mon. Böhm. Trilob., p. 91, pl. v, fig. 55.
1848. *Encrinurus punctatus*, Kutorga, Verh. Miner. Gesell., 1847, p. 299, pl. viii, fig. 4.
1850. *Cybele punctata*, Fletcher, Quart. Journ. Geol. Soc., vol. vi, p. 158, pl. xxxii, figs. 1—5.
1851. *Encrinurus punctatus*, Salter, Quart. Journ. Geol. Soc., vol. vii, p. 172, pl. ix, fig. 4.
1851–6. *Encrinurus punctatus*, Bronn, Leth. Geogn., 3rd ed., vol. i, p. 658 ; Atlas, pl. ix ², figs. 24 *a*—*c*.
1853. *Encrinurus punctatus*, Salter, Mem. Geol. Surv., dec. vii, p. 6, pl. iv, figs. 15, 16.
1854. *Encrinurus stokesii*, M'Coy, Synops. Palæoz. Foss. Woodw. Mus., p. 158.
1854. *Cryptonymus punctatus*, Angelin, Pal. Scand., p. 3, pl. iv, figs 4—8.
1857. *Encrinurus punctatus*, Nieszkowski, Mon. Trilob. Ostseeprov. (Archiv f. Naturk. Liv.-Est.-Kurl., ser. i, vol. i), p. 604, pl. iii, figs. 6, 7.
1858. *Encrinurus punctatus*, Hoffmann, Verh. Miner. Gesell., p. 35, pl. iii, fig. 5.
1865. *Encrinurus punctatus*, Salter and Woodward, Chart Foss. Crust., p. 13, fig. 52.
1867. *Encrinurus punctatus*, Murchison, Siluria, 4th ed., Foss. 14, fig. 10 ; Foss. 64, fig. 5 ; pl. x, fig. 5.
1872. *Encrinurus punctatus*, Murchison, ibid., 5th ed., p. 235, Foss. 65, fig. 5.

[1] Salter, 'Quart. Journ. Geol. Soc.,' vol. xiii (1857), p. 211, pl. vi, figs. 15—17.

1873. *Encrinurus punctatus*, Salter, Cat. Camb. Silur. Foss. Woodw. Mus., pp. 77, 131.
1874. *Encrinurus punctatus*, Steinhardt, Die preuss. Geschieb. gefund. Trilob. (Beitr. Naturk. Preuss. Phys. Oekon. Gesell. Königsberg., st. 3), p. 58, pl. iv, fig. 15.
1875. *Encrinurus punctatus*, Baily, Char. Brit. Foss , p. 50, pl. xvi, fig. 12; p. 67, pl. xxiii, fig. 2.
1876. *Encrinurus punctatus*, Roemer, Leth. Geogn. I, Atlas, pl. xvii, figs. 8 *a*, *b*.
1877. *Encrinurus* (*Cybele*) *punctatus*, Woodward, Cat. Brit. Foss. Crust., p. 36.
1878. *Cryptonymus punctatus*, Vogdes, Monogr. genera *Zethus, Cybele, Encrinurus*, and *Cryptonymus* (Charleston), p. 18.
1879. *Encrinurus punctatus*, Nicholson and Etheridge, Mon. Silur. Foss. Girvan, fasc. i, p. 109, pl. viii, figs. 1—3, non fig. 4.
1881. *Encrinurus punctatus*, Schmidt, Rev. Ostbalt. Silur. Trilob., pt. i, p. 225, pl. xiv, figs. 11—13; pl. xv, fig. 18.
1886. *Encrinurus punctatus*, Novak, Studien an Hypost , IV (Sitzb. böhm. Gesell. Wiss.), p. 429, pl. i, figs. 1—8.
1888. *Encrinurus punctatus*, Wigand, Zeitschr. deutsch. geol. Gesell., vol xl, p. 91, pl. x, fig. 23.
1890. *Encrinurus punctatus*, Pompecki, Die Trilobf. Ost.-West-preuss. Diluv. Geschieb. (Beitr. Naturk. Preuss. Phys. Oekon. Gesell. Königsberg, st. 7), p. 40, pl. v, figs. 21, 22; pl. vi, fig. 32.
1893. *Encrinurus punctatus*, Vogdes, Bibliogr. Pal. Crust. (Calif. Acad. Sci.), p. 308.
1899. *Encrinurus punctatus*, Mem. Geol. Surv., Silur. Rocks Brit., vol. i, Scotland, pp. 503, 505, 529, 530, 532, 536, etc.

Remarks.—As Nicholson and Etheridge have remarked (*op. cit.*, p. 109), the variety *arenaceus* is much commoner than the variety *calcareus* in the Girvan district. The specimens from Penkill (Nicholson and Etheridge, *op. cit.*, pl. viii, figs. 1, 3), Camregan Wood, Bargany Pond Burn, and Newlands are like the typical Wenlock examples from Dudley, and have a pygidium with the axis possessing a median smooth space bearing a tubercle opposite every fifth or sixth ring, the rings not being complete in the centre, as Salter mentioned (*op. cit.*, 1853). The specimens, on the other hand, from Woodland Point and Mulloch Hill (*op. cit.*, pl. viii, fig. 2) have no clear space down the middle of the axis, as the rings are continuous across it, and there is no median row of tubercles. In other respects the pygidia appear to be identical. The head-shields are not sufficiently preserved to feel sure of any points of difference, but the glabella in those of the second group appears to be relatively somewhat longer and to have a more slender neck.

None of these Silurian specimens have the mucro to the pygidium well preserved, but it appears to have existed in some of the above-mentioned examples from Penkill, Bargany, Newlands, and Camregan, and these specimens therefore belong to the variety *calcareus*, which, as Salter stated, is the common Wenlock variety.

The Ordovician representatives of the species, on the other hand, resemble those from Mulloch Hill and Woodland Point. The axial rings are continuous across the axis and fewer in number (18–25) than in the other form. The pleuræ and rings are finely granulated, and no definite row of tubercles exists on the axis or elsewhere. In all the tail ends abruptly, as in the variety *arenaceus*.

Nicholson and Etheridge figure a crushed example from Craighead (*op. cit.*, p. 109, pl. viii, fig. 4). It appears to me that this form should certainly rank as a distinct variety, if not species.

Salter does not state that the variety *arenaceus* differs from the variety *calcareus* by anything but the non-mucronate pygidium, and makes no mention of the distinctive characters of the axis.

There is one slightly imperfect hypostome of an *Encrinurus* from Dow Hill probably referable to this species and the variety *arenaceus*. It does not appear to differ from typical examples of the Wenlock *E. punctatus*, except in the anterior end being rather more obtusely rounded.

(1) *E. punctatus*, var. *calcareus*.

Collections.—Mrs. Gray; Museum of Practical Geology; Edinburgh Museum.

Horizons and Localities.—Saugh Hill Group (M. Llandovery): Newlands. Camregan Group (U. Llandovery): Camregan Wood; ? Bargany Pond Burn. Penkill Group (Tarannon): Penkill. Bargany Group (Tarannon): Bargany Burn. Wenlock Series: Knockgardner.

(2) *E. punctatus*, var. *arenaceus*.

Collections.—Mrs. Gray; Museum of Practical Geology; Edinburgh Museum; Woodwardian [Sedgwick] Museum.

Horizons and Localities.—Stinchar Limestone Group (Llandeilo): Craighead; Minuntion. Balclatchie Group (Llandeilo): Ardmillan; Dow Hill. Drummuck Group (U. Bala): Penwhapple Glen. Mulloch Hill Group (L. Llandovery): Mulloch Hill; Rough Neuk. Saugh Hill Group (M. Llandovery): Woodland Point.

2. **Encrinurus multisegmentatus** (Portlock), 1843. Plate XVI, figs. 9—11*a*.

1843. *Amphion multisegmentatus*, Portlock, Geol. Rep. Londond., p. 291, pl. iii, fig. 6.

1843. *Ampyx ? baccatus*, Portlock, ibid., p. 262, pl. iii, fig. 11.

1846. *Encrinurus multisegmentatus*, M'Coy, Synops. Silur. Foss. Ireland, p. 46.

1853. *Encrinurus multisegmentatus*, Salter, Mem. Geol. Surv., dec. vii, art. iv, p. 7.

1854. *Encrinurus multisegmentatus*, Morris, Cat. Brit. Foss., 2nd ed., p. 107.

1857. *Encrinurus multisegmentatus*, Nieszkowski (*e. p.*), Mon. Trilob. Ostseeprov. (Archiv f. Naturk. Liv.-Est.-Kurl., ser. 1, vol. i), p. 609.

1858. *Encrinurus multisegmentatus*, Schmidt (*e. p.*), Untersuch. Silur. Form. Esth. (Archiv f. Naturk. Liv.-Est.-Kurl., ser. 1, vol. ii), p. 190.

1861. *Encrinurus multisegmentatus*, F. Römer, Foss. Faun. v. Sadewitz, p. 75, pl. viii, figs. 7 *a, b, c*.

1868. *Encrinurus multisegmentatus*, Bigsby, Thesaur. Silur., p. 51.

1877. *Encrinurus multisegmentatus*, Woodward, Cat. Brit. Foss. Crust., p. 35.

1881. *Encrinurus multisegmentatus* (?), Schmidt, Rev. Ostbalt. Silur. Trilob., pt. i, p. 227, pl. xiv, figs. 14, 15; pl. xv, figs. 19, 20.

1884. *Encrinurus multisegmentatus*, Törnquist, Undersökn. Siljansom. Trilobitf. (Sver. Geol. Undersökn., Ser. C, No. 66), p. 24, pl. i, figs. 18, 19.
1904. *Encrinurus multisegmentatus*, Reed, Geol. Mag. [5], vol. i, p. 387.

Remarks.—This species was briefly described and imperfectly figured by Portlock (*op. cit.*). A further description, based on Russian specimens ascribed to it, has more recently been given by Schmidt (*op. cit.*, 1881). The Girvan specimens, which probably belong to it, are fairly complete, one from the Starfish Bed showing the thorax with twelve segments attached to the pygidium, and another, also from the Starfish Bed, showing a portion of the head-shield attached to five thoracic rings.

The head-shield called *Ampyx* (?) *baccatus* by Portlock (*op. cit.*, pl. iii, fig. 11) is now considered to belong to *E. multisegmentatus*, and Schmidt's Russian example (*op. cit.*, pl. xv, figs. 19 *a*, *b*) bears a still closer resemblance to those from Girvan than does the Irish one, in the larger size but smaller number of the tubercles on the glabella. The frontal marginal row of tubercles, and the coarse tuberculation of the cheeks are also well seen in our specimens. The genal angle (not preserved in Schmidt's specimen) is produced into a rounded spine projecting backwards and slightly outwards to the level of the third thoracic ring or perhaps farther, as the tip is broken off. At the base of the spine is a large tubercle, and two similar ones are seen in front. The eye is situated at about the level of the middle of the glabella, and is borne on an eye-stalk projecting forwards and outwards. The neck-ring is narrow and is separated by a strong occipital furrow from the swollen cheek, which rises nearly as high as the glabella. The glabella is pear-shaped, but expands gradually towards the front, and is not contracted in the middle nor specially inflated in front. It does not reach the front margin of the head-shield, which is furnished with a distinct border bearing along its edge 6—8 large tubercles. The axial furrows are deep. The tubercles on the glabella are large, coarse, rounded, and of subequal size; near the base in one specimen are two rings of 5—6 tubercles, while further forwards they are irregularly arranged.

The thorax consists of twelve segments. The axis is of moderate width, scarcely tapering at all posteriorly; each axial ring is slightly swollen on the axial furrow into a lateral node. The pleural portions are about half as wide again as the axis. The inner part of each pleura is straight and horizontal; the outer part is strongly bent down, and in the posterior pleuræ it is also a little bent back. Each pleura consists of a narrow, slightly raised anterior rim, separated by a wider, shallow rounded groove from a strongly raised, prominent rounded ridge, occupying the whole posterior half of the pleura, but tapering a little towards the free rounded extremity. This ridge seems to bear a few small tubercles. The axial furrows are broad.

The pygidium is triangular and acutely pointed, but not produced into a mucro. The lateral lobes are bent down gently at the sides anteriorly, but more

strongly towards the extremity, and consist of ten or eleven simple pleural ridges, separated by strong simple furrows. The pleural ridges terminate on the margin in free, short, obtuse points. The axis is long, narrow, and slowly tapering, but does not quite reach the posterior end of the pygidium. It is completely ringed, but only the first 12—15 rings (in casts), or even fewer, are complete, the posterior 10 or more being incomplete in the middle. In some specimens only the first 8—12 are complete. A similar variation is noticed by Schmidt in *E. seebachi*, Schmidt (*op. cit.*, p. 231); but in Portlock's type of *E. multisegmentatus*, and in the Haverfordwest specimens the rings are continuous as in the Girvan specimen. The median space down the axis is smooth and bears no tubercles, but there are 1—3 tubercles frequently visible along the centre of the pleuræ.

Two pygidia from Shalloch Mill which should probably be ascribed to this species have more the shape of *E. seebachi* as figured by Schmidt (*op. cit.*, pl. xiv, figs. 24—26), being more sharply pointed and laterally compressed, but in other respects agree with *E. multisegmentatus*.

The pygidium of the latter species has been compared with *E. multiplicatus*, Salter, by the present writer,[1] and it may be remarked that the latter species differs chiefly from these Girvan specimens by the longitudinal lineation of the pleuræ and by the different course and origin of the last pleuræ. The last pair of pleuræ in *E. multisegmentatus* arises close to the tip of the axis instead of at the 16th axial ring, as Törnquist (*loc. cit.*, 1884) shows in his figure of a Swedish specimen.

Collection.—Mrs. Gray.

Horizons and Localities.—Whitehouse Group (M. Bala): Shalloch Mill. Drummuck Group (U. Bala): Starfish Bed, Thraive Glen.

Genus **CYBELE**, Lovén.

1. **Cybele bellatula** (Dalman), 1826. Plate XVI, figs. 14—17.

1826. *Calymene bellatula*, Dalman, K. Svensk. Vet. Akad. Handl., p. 228, pl. i, figs. 4*a*—*d*.
1828. *Calymene bellatula*, Dalman, Palæad., p. 36, pl. i, fig. 4.
1830. *Zethus verrucosus*, Pander, Beitr. z. Geogn. Russl., p. 140, pl. iv *c*, fig. 4; pl. v, fig. 5.
1845. *Cybele bellatula*, Lovén, Ofv. K. Svensk. Vet. Akad. Förhandl., p. 110, pl. ii, fig. 3.
1848. *Zethus verrucosus*, Volborth, Verhandl. Miner. Gesell. St. Petersb., p. 8, pl. i, figs. 5—7.
1854. *Cryptonymus bellatulus*, Angelin, Pal. Scand., p. 3, pl. iv, figs. 1—3; and p. 89.
1858. *Zethus verrucosus*, Hoffmann, Verhandl. Miner. Gesell. St. Petersb., p. 32, pl. iii, fig. 4.
1860. *Cryptonymus bellatulus*, Eichwald, Leth. Ross., p. 1414.
1860. *Cryptonymus parallelus*, Eichwald, ibid., p. 1417.
1865. *Cybele dentata*, Kjerulf, Veiviser, p. 6.

[1] Reed, 'Geol. Mag.' [4], vol. viii (1901), p. 107; ibid. [5], vol. i (1904), p. 387, pl. xii, fig. 5.

1881. *Cybele bellatula*, Schmidt, Rev. Ostbalt. Silur. Trilob., pt. i, p. 203, pl. xiii, figs. 9—13; pl. xv, figs. 1—5.

1882. *Cybele bellatula*, Brögger, Die Silur. Ét. 2 und 3, p. 136, pl. vi, figs. 2, 2 *a*, 2 *b*.

1888. *Cybele bellatula*, Wigand, Zeitschr. deutsch. geol. Gesell., vol. xl, p. 88, pl. x, fig. 15.

1901. *Cybele bellatula*, Lindström, K. Svensk. Vet. Akad. Handl., vol. xxxiv, No. 8, p. 52, pl. iv, fig. 2.

Remarks.—Certain head-shields from Dow Hill bear a close resemblance to *C. bellatula* (Dalman), and are undoubtedly distinct from other British species. The glabella in these Girvan specimens is oval, broadest across the middle, with three pairs of lateral lobes marked off by deep furrows, of which the two posterior furrows are straight, almost horizontal, reach more than one third across the glabella and deepen at their inner ends. The anterior furrows are oblique and cut into the anterior end of the glabella, defining between them a triangular frontal lobe. The axial furrows are deep. The occipital ring is prominent, rounded, and widest in the middle. The fixed cheeks are nearly twice as wide as the glabella, have a convex surface, and towards the genal angle are bent downwards and backwards. The eye-stalks are at the level of the anterior lateral lobes of the glabella, and are stout and prominent, rising up almost vertically from the cheek. They are distant from the glabella about half its width, and are connected with it by a faint ridge. The cheeks are finely pitted, but the glabella seems to be feebly granulated. The neck-segment is narrow and smooth, but widens towards the genal angles. A strong neck-furrow separates it from the cheek.

There does not appear to be any marked point of difference between these head-shields and those of *C. bellatula*, except that the eye is not placed quite so far forward and is directed rather laterally instead of anteriorly. Free cheeks probably belonging to this same form are found at Dow Hill and Balclatchie; they are of triangular shape with an elevated pitted surface bearing a tall stalked eye, and the rounded border is produced anteriorly into the characteristic pointed process. In one specimen belonging to the same species we find the head-shield attached to eight thoracic segments. The free ends and extra-fulcral portions of the pleuræ are broken off, but each pleura is seen to be slightly contracted at its base on the axial furrow; the pleural furrow is narrow and does not arise quite at its base but runs out to the fulcrum nearly parallel with the anterior edge of the pleura; the portion of the pleura behind the pleural furrow is nearly twice as wide as the part in front, and is more strongly raised and prominent, bearing traces of one or two tubercles in addition to the general granulation which covers the whole surface of the pleura. The axial rings are furnished with low rounded lateral nodes on the axial furrows.

There are certain pygidia from Dow Hill and Balclatchie which are probably referable to this species. In one specimen from Dow Hill there are three thoracic segments attached; the pleuræ are strongly curved backward, and produced into long free rounded spines; the rounded surface of the pleura is divided as far out as

the fulcrum by a slightly diagonal narrow furrow, situated nearer the anterior than the posterior margin. (There is a fragment of an apparently similar thorax in Mrs. Gray's collection from Craighead, and another from Balclatchie with one pair of pleuræ produced into very long spines.) These pygidia have the following characters: Shape triangular, acutely pointed behind, and contracted posteriorly, as broad (across the front) as long. Axis long, narrow, gently tapering, extending two thirds the length of the pygidium, and with a width at front end less than one third that of the pygidium; possessing 20—25 incomplete narrow rings, leaving a smooth central band down axis. Behind the axis and extremities of the pleuræ is a narrow tapering post-axial piece with a median ridge. Lateral lobes broad in front and flattened horizontally, decreasing rapidly in width behind: each consisting of four complete pleuræ and one half pleura, successively decreasing in size and strength of curvature, the anterior pair being very strongly curved; the half pleura is straight and lies along the side of the axis. Each pleura consists of a large posterior raised, rounded ridge and a much narrower anterior ridge which scarcely reaches the axis. The pleuræ bear a few large tubercles. The posterior ridge of the second pair of pleuræ forms the greater part of the lateral margin of the pygidium, and the extremities of the third pair bend out behind it at the end of the axis to terminate in short, freely projecting points.

These pygidia bear a general resemblance to that of *C. bellatula*, particularly in the short axis and post-axial piece, as is well shown in Schmidt's figure (*op. cit.*, pl. xv, fig. 5), but the rings on the axis are much more numerous.

The production of one pair of thoracic pleuræ into longer spines than the rest, and the enlargement of this thoracic segment, which are noticeable in some fragments of a thorax from Balclatchie and Craighead, perhaps attributable to *C. bellatula*, are met with also in *C. winchelli*, Clarke,[1] from the Galena Limestone of Minnesota, and in *C. loveni*, Linnarsson (see below).

Collection.—Mrs. Gray.

Horizons and Localities.—Balclatchie Group (Llandeilo): Dow Hill; Balclatchie. (?) Stinchar Limestone Group (Llandeilo): Craighead.

2. **Cybele loveni**, Linnarsson, 1869, var. nov. **girvanensis**. Plate XVII, figs. 1—4.

1876. *Cybele rugosa*, Armstrong and Young, Cat. West. Scot. Foss., p. 16.

1878. *Cybele rugosa*, Nicholson and Etheridge, Mon. Silur. Foss. Girvan, fasc. i, p. 112, pl. xiv, fig. 13; pl. viii, figs. 5—7.

1899. *Cybele rugosa*, Mem. Geol. Surv., Silur. Rocks Brit., vol. i, Scotland, pp. 672, 688.

[1] Clarke, 'Lower Silur. Trilob. Minnesota,' p. 747, fig. 59 ('Final Rep. Geol. Nat. Hist. Surv. Minnes.,' vol. iii, 1894).

Remarks.—The carefully executed figure and minute description of *Cybele loveni* given by Linnarsson,[1] and the large series of finely preserved specimens in Mrs. Gray's collection from Thraive Glen, including some nearly perfect individuals with numerous head-shields, thoraces, and pygidia, have led me to identify this Girvan form with Linnarsson's species rather than with Portlock's *C. rugosa*,[2] to which Nicholson and Etheridge referred the similar but poorer examples from Drummuck. The examination of Portlock's type specimen of *C. rugosa* fully confirms my view. Furthermore, M'Coy's[3] specimen of the latter species from Coniston, though closely allied to the Girvan form, cannot be considered identical with it.

There are a few minor points in which the Girvan specimens differ from the Swedish *C. loveni*, and they are sufficient to indicate a definite variety. The characters of the head-shield agree exactly with those of *C. loveni*, Linnarsson, except in (1) the presence of a small projecting knob in front of the glabella (preserved only in some specimens); (2) the glabella does not increase in width anteriorly, but is parallel-sided; and (3) the fused lateral lobes of the glabella form a rather narrower zone on each side.

The thorax agrees, apparently in all respects, with that of *C. loveni*, the prolongation of the sixth pair of pleuræ into extraordinarily long free curved spines to some distance behind the tip of the pygidium being beautifully exhibited in many of the Girvan specimens.

The pygidium, however, shows several points of difference; it is narrower in shape; the axis is rather longer, being about three fourths the total length of the pygidium, it is regularly conical and tapers more slowly, the sides converging posteriorly at about 20°. There are 22—28 rings on the axis, interrupted along the middle line for the whole length of the axis, and generally devoid of tubercles. (In *C. rugosa* tubercles are situated at intervals along this space, but only one of our specimens shows two minute tubercles, one at the fifth and the other at the eleventh ring.) Behind the axis is a narrow-pointed post-axial piece. The lateral lobes are elongate and narrow, being nowhere wider than the front end of the axis. They each consist of three pleuræ and one half-pleura. The first pleura is divided by a median groove into two equally strong and tuberculated ridges, arising opposite the first three or four axial rings, and arching at first slightly outwards, but then bending backwards and a little inwards. The outer (anterior) ridge is prolonged along the side of the pygidium to end in a short free point bent outwards. The second pleura is smaller and lies almost parallel with the axis: it consists of a narrow anterior ridge and a slightly larger tuberculated posterior one. The third pleura is still smaller and lies parallel with the axis; only the posterior

[1] Linnarsson, 'Vestergotl. Camb. Silur. Aflagr.' (1869), p. 63, pl. i, fig. 14.

[2] Portlock, 'Geol. Rep. Londond.,' p. 302, pl. v, fig. 10 (*Ogygia rugosa*).

[3] M'Coy, 'Synops. Pal. Foss Woodw Mus.,' Appendix A, p. iii, pl. i G, fig. 8.

ridge is well developed, the anterior one being very narrow and not extending to the base of the pleura. The half-pleura is a very narrow straight tuberculated ridge lying closely pressed against the axis. The ends of the pleuræ are gathered closely together behind the axis, and then spread out in a fan-shaped manner to form the tip of the tail. The narrow wedge-shaped post-axial piece separates the pleuræ of the opposite sides behind the axis. But, unfortunately, no example has the extremity of the pygidium in a first-rate state of preservation.

Linnarsson's figure of *C. loveni* does not indicate the pygidial characters very minutely, but so far as can be judged they are not quite identical with those of the Girvan specimens. Hence these latter may be recognised as a local variety and termed var. *girvanensis*.

C. loveni was recorded by Marr [1] in the Settle district in 1887, for the first time in the British Isles.

Collections.—Mrs. Gray; Museum of Practical Geology; Edinburgh Museum.

Horizon and Localities.—Drummuck Group (U. Bala): Thraive Glen; Drummuck.

3. **Cybele** cf. **aspera,** Linnarsson, 1869. Plate XVI, figs. 12, 13.

? 1878. *Cybele verrucosa,* Nicholson and Etheridge, Mon. Silur. Foss. Girvan, fasc. i, p. 111 (*non* fig. 5 *c*).

? 1899. *Cybele verrucosa,* Mem. Geol. Surv., Silur. Rocks Brit., vol. i, Scotland, pp. 509, 514, 688.

Remarks.—A species of *Cybele* has been recorded from several horizons and localities in the Girvan district as *C. verrucosa*, Dalman, but few of the specimens in Mrs. Gray's or other collections which I have examined appear to correspond precisely with this type. One from Craighead which, perhaps, may be referred to it, is mentioned below, but the majority show features which do not agree with *C. verrucosa* as Lovén[2] figured and described it, though later authors have widely diverged from his definition, so that current synonymies have not much value. Of other species of *Cybele*, *C. aspera*, Linnarsson,[3] appears to bear a greater resemblance to the form from the Balclatchie Beds which is here described; the points of similarity are mentioned below. Unluckily, none of the specimens are well preserved. In the head-shield from Ardmillan the glabella is strongly convex and subclavate in shape, but the frontal lobe is not so transversely expanded as is usual in *C. verrucosa*; there are three pairs of deep lateral pits which are not continued into the axial furrows, and thus mark off incompletely three pairs of lobes, as in *C. aspera*, whereas in *C. verrucosa* there are true furrows; the anterior

[1] Marr, 'Geol. Mag.' [3], vol. iv (1887), p. 35.

[2] Lovén, 'Ofv. K. Svensk. Vet. Akad. Förhandl.,' no. 3 (1845), p. 52, pl. i, fig. 5 *a*.

[3] Linnarsson, 'Vestergotl. Camb. Silur. Aflagr.' (1869), p. 62, pl. i, figs. 11—13.

pair of pits is the smallest and the basal the largest. There is also a strong, broad occipital furrow furnished likewise with a similar pair of deep lateral pits, situated in the same longitudinal line as those on the glabella. The axial furrows are shallow and wide, and do not diverge suddenly in front as they do in *C. verrucosa*, but resemble in their course those of *C. aspera*, ending also similarly in a pair of large, deep, terminal pits. The cheeks are somewhat wider than in *C. verrucosa*, and the whole head-shield seems more transversely extended. The tubercles on the glabella are large, prominent, few in number, and tend to be arranged in pairs (as in *C. aspera*), and have some smaller tubercles interspersed. The anterior border, which Linnarsson figures in *C. aspera* as armed with marginal spiniform tubercles, is not preserved in our specimen.

A complete description of this Girvan form is not possible owing to the poorness of the available material, but it seems to me to bear more resemblance to *C. aspera* than to *C. verrucosa*, though possibly it may be found to be specifically distinct from both.

Dimensions.—

	I (From Ardmillan).	II (From Dow Hill, slightly compressed).
Length of head-shield . .	9·0 mm.	—
,, of glabella . .	7·0 ,,	6·50 mm.
Width of ,, at base .	6·0 ,,	3·25 ,,
,, of ,, in front .	—	5·25 ,,
,, of cheeks at base . .	—	8·00 ,,

Collections.—Mrs. Gray (I, II); Museum of Practical Geology (III).

Horizons and Localities.—Balclatchie Group (Llandeilo): Ardmillan; Dow Hill.

4. **Cybele verrucosa,** Dalman ?.

1822. 'Chaperon d'un Trilobite,' Brongniart, Hist. Nat. Crust. Foss., p. 145, pl. iv, fig. 11.
1826. *Calymene ? verrucosa*, Dalman, K. Svensk. Vet. Akad. Handl., p. 285.
1828. *Calymene ? verrucosa*, Dalman, Palæad., p. 76.
1828. *Calymene ? verrucosa*, Dalman, Arsberätt. Zool. Arbet., p. 134, note [1].
1829. *Calymene ? verrucosa*, Férussac, Bull. Sci. Nat., vol. xix, p. 128.
1845. *Trilobites* (*Calymene*) *verrucosa*, Lovén, Ofv. K. Svensk. Vet. Akad. Förhandl., no. 3, p. 52, pl. i, figs. 5 *a*—*c*.
1845. *Cybele verrucosa*, Lovén, *loc. cit.*, no. 4, p. 111.

Remarks.—The one head-shield of a *Cybele* from Craighead which may be attributed to this species closely resembles Lovén's figure and description, but the larger tubercles on the glabella tend to range in four or five pairs down the centre. The state of preservation renders the specific identification doubtful; and the reason

for the omission of the synonymy of the species since Lovén's paper was published is, because I have grave doubts which of the many types of *Cybele* commonly referred to it by subsequent authors and figured under this name can be considered as truly specifically identical. At any rate there are no other specimens from Girvan which can be probably attributed to it.

Dimensions.—

Length of glabella	. . . .	6·0 mm.
Width of ,, in front	. . .	4·5 ,,
,, ,, at base	. . .	3·0 ,,

Collection.—Museum of Practical Geology.

Horizon and Locality.—Stinchar Limestone Group (Llandeilo): Craighead.

5. **Cybele,** sp. ind. (*a*). Plate XVII, fig. 5.

1879. *Cheirurus*? sp. ind. *b*, Nicholson and Etheridge, Mon. Silur. Foss. Girvan, fasc. ii, p. 203, pl. xiv, fig. 12.

Remarks.—The specimen from Balclatchie which Nicholson and Etheridge figured and described as the head-shield of '*Cheirurus*? sp. ind. *b*,' shows the essential characters of a *Cybele*; but to what described species it should be referred is uncertain, and it is probably new. The figure does not represent the fixed cheeks accurately, for they are much flatter, and the anterior edge is hidden by the matrix; the irregular lines on the surface are cracks due to slight crushing, but there is present a natural close pitting, while a straight, rounded, ocular ridge may be observed to run rather obliquely backwards from the first lateral furrow of the glabella to the eye, bearing two large remote tubercles upon it. A similar tubercle lies in the middle of the cheek behind the ocular ridge. The pre-glabellar triangular prominence on the front border resembles that in *C. loveni* var. *girvanensis* and appears to be an enlargement of that seen in *C. bellatula*. In the general characters of the glabella and cheeks this specimen is allied to *C. coronata*, Nieszk., and to *C. rex*, Schmidt,[1] as well as to *C. bellatula*, Dalman.

Collection.—Mrs. Gray (f. M.).

Horizon and Locality.—Balclatchie Group (Llandeilo): Balclatchie.

6. **Cybele**, sp. ind. (*b*). Plate XVII, figs. 6—8.

Remarks.—The Llandeilo beds at Dow Hill have furnished a number of more or less imperfect head-shields and pygidia, which from point of size should apparently be associated together, and are not referable to any described species. In

[1] Schmidt, 'Rev. Ostbalt. Silur. Trilob.,' pt. ii, pp. 209 and 213, pl. xiii, figs. 21—27.

this form the head-shield is nearly three times as wide as long, and of a broad, semicircular shape. The glabella is short, convex, subcylindrical, expanding a little in front, about three quarters as wide as long, slightly swollen in front, and possessing three pairs of nodular lateral lobes, of which the anterior pair is the largest and the basal the smallest. The frontal lobe appears to be transversely rhomboidal, and has a pair of conspicuous tubercles in the middle. There is also a single tubercle midway between the anterior pair of lateral lobes. A strong occipital furrow marks off a convex neck-ring, furnished with a median tubercle. The axial furrows are deep. The fixed cheeks are very wide, being from two to three times the width of the glabella, and are gently convex, and bent down and backwards towards the genal angles. The neck-segment is narrow, but widens towards the genal angles, and is marked off from the cheeks by a strong furrow. The genal angles are rounded. The posterior branch of the facial suture appears to run nearly parallel with the hinder border of the head. The eyes are small, elevated, and situated at the level of the anterior lateral lobes of the glabella, lying at a distance from the glabella of more than half its width. A narrow, rounded, ocular ridge connects them with the glabella. The cheeks are pitted, and bear also four or five large remote tubercles. A few small tubercles are scattered over the glabella.

The pygidium, which may be associated with this type of head-shield on account of its size, is sub-oval, with a conical axis tapering gradually to a bluntly pointed extremity, but not reaching the posterior margin of the pygidium. The axis is furnished with 2—3 complete rings at its anterior end, followed by about twelve narrow rings incomplete in the middle, leaving a smooth central space down the axis. The lateral lobes are formed by four pairs of simple, rounded, curved ribs of equal size, ornamented with small tubercles and separated by rather deep furrows. These ribs curve outwards and then backwards to run almost parallel with the axis, and end behind it in short free points of sub-equal length.

Dimensions.—

Width of head-shield	13·0 mm.
Length of ,, (imperfect) . . .	+ 4·5 ,,
,, ,, glabella	4·5 ,,
Width ,, ,, at base . . .	3·0 ,,
Length ,, pygidium	3·5 ,,

Affinities.—The species which seem most nearly allied to this form are *C. kutorgæ*, Schmidt,[1] and *C. brevicauda*, Ang.[2] The head-shield also recalls that of *C. verrucosa*, Dalm., but the state of preservation does not admit of a minute comparison.

[1] Schmidt, 'Rev. Ostbalt. Silur. Trilob.,' pt. ii, p. 217, pl. xv, figs. 11—14.

[2] Angelin, 'Pal. Scand.,' p. 89, pl. xli, fig. 14; and Schmidt, *op. cit.*, p. 219, pl. xiv, figs. 7—10; pl. xv, figs. 15—17.

Collections.—Mrs. Gray; Museum of Practical Geology.
Horizon and Locality.—Balclatchie Group (Llandeilo): Dow Hill.

Genus **DINDYMENE,** Corda.

1. **Dindymene cordai,** Etheridge and Nicholson, 1878. Plate XVII, figs. 9—11.

1878. *Dindymene cordai,* Nicholson and Etheridge, Mon. Silur. Foss. Girvan, fasc. i, p. 115, pl. viii, fig. 8, and p. 116, figs. 5 A, B.
? 1880. *Staurocephalus*? sp. ind., Nicholson and Etheridge, *op. cit.*, fasc. iii, p. 283, pl. xix, fig. 3.
1899. *Dindymene cordai,* Mem. Geol. Surv., Silur. Rocks Brit., vol. i, Scotland, pp. 517, 524, 672, 689.

Specific Characters.—Head-shield almost semicircular, slightly parabolic, strongly convex from side to side and from back to front; the sides are suddenly bent down on each side of the glabella, giving an angulated appearance to the front aspect. Glabella strongly convex, higher than cheeks, most elevated at about one third its length from base; pyriform in shape, and projecting in front of the cheeks; widest at anterior end, narrowing posteriorly to base to about half the anterior width. No lateral furrows or lobes. Axial furrows deep, strong, nearly straight, converging posteriorly at about 30°. Occipital furrow strong. Occipital ring narrow. Cheeks strongly bent down on each side, tumid, not so elevated as glabella, subtriangular in shape, arched outward in front of genal angles, more than twice as wide as glabella at base. Genal angles broadly rounded. Neck segment rounded, narrow, marked off by strong furrows, and passing at genal angles into raised, rounded, smooth, lateral border surrounding head-shield and marked off from cheeks and glabella by strong, continuous, marginal furrow. No facial sutures or eyes. Surface of glabella and cheeks uniformly tuberculated, and cheeks in addition pitted. A single large median tubercle situated at about one third the length of the glabella.

Thorax as long as head-shield, consisting of ten segments. Axis convex, prominent, gradually tapering; axial rings rounded, with small median tubercle on each between a pair of lateral tubercles; on fourth ring a strong median spine (base only preserved) takes the place of the median tubercle. Pleuræ rounded, divided into a posterior, prominent, raised, rounded ridge and a much narrower, lower, rounded, anterior band; pleuræ in contact only for a distance about equal to width of axis, then free and separate, tapering to long free points. Pleuræ strongly arched downwards, and successively more curved backwards towards pygidium till they lie almost parallel with axis. A single row of minute tubercles ornaments each pleura.

Pygidium narrow, a little more than half the length of thorax; axis long, conical, consisting of 10—12 rings, of which only the first 7—8 are distinct. Axial furrows narrow. Lateral lobes composed of only two pairs of pleuræ, in contact for short distance and corresponding with first two rings of axis. First pair resembling thoracic pleuræ, curved backwards strongly, nearly parallel with axis, with long, free, slightly curved, pointed ends. Second pair closely pressed against sides of axis and meeting behind it, to end in short free points, making a bifurcate extremity to the pygidium.

Dimensions.—

Length of head-shield . . .	5·5 mm.
Width „ „	10·0 „
Width of glabella at base . . .	2·5 „
Length of thorax	6·5 „
Length of pygidium	4·0 „

Affinities.—This species is closely allied to *D. frederici-augusti*, Corda,[1] as Nicholson and Etheridge have pointed out. The Swedish species *D. ornata*, Linnarsson,[2] is perhaps as closely related, and it possesses the tubercle or spine on the fourth axial ring of the thorax. The only other British species of *Dindymene* (*D. hughesiæ*, Reynolds[3]) differs in the relatively larger head, distinctive ornamentation, characters of the pygidium, and absence of genal spines.

The specimen figured by Nicholson and Etheridge as '*Staurocephalus* ? sp. ind.' (*op. cit.*, fasc. iii, 1880, p. 283, pl. xix, fig. 3) seems to be an imperfect example of *D. cordai*.

Collection.—Mrs. Gray (f. M.).

Horizon and Localities.—Whitehouse Group (M. Bala): Whitehouse Bay. Drummuck Group (U. Bala): Thraive Glen; Drummuck.

Family CALYMENIDÆ.

Genus **CALYMENE**, Brongniart.

1. **Calymene blumenbachi,** Brongniart, 1822. Plate XVII, figs. 12, 13 (?).

1750. A Nondescript Petrified Insect, Lyttelton, Phil. Trans., vol. xlvi, pp. 598, 600, pl. i, figs. 3—12; pl. ii.

1759. *Entomolithus paradoxus*, Linnæus, Act. Soc. Sci. Holm., p. 22, pl. i, fig. 3.

---

[1] Barrande, 'Syst. Silur. Bohême,' vol. i, p. 818, pl. xliii, figs. 25, 26.

[2] Linnarsson, 'Vestergotl. Camb. Silur. Aflagr.,' p. 64, pl. i, figs. 15—17.

[3] Reynolds, 'Geol. Mag.' [4], vol. i (1894), p. 108, pl. iv, figs. 1, 5; Reed, ibid., p. 246, pl. vii, figs. 4, 5.

1781. *Trilobus tuberculatus*, Brünnich, Dansk. Vid. Selsk. Skrifter; Nye Samling, vol. i, p. 389.
1810. *Trilobites tuberculatus*, Blumenbach, Abbild. Naturk. Gegenst., pt. i, fig. 50.
1811. *Entomolithus paradoxus*, Parkinson, Organic Remains, vol. iii, p. 263*, pl. xvii, figs. 11, 13, 14.
1818. *Entomostracites tuberculatus*, Wahlenberg (*e. p.*), Petrif. Suec., p. 31.
1821. *Entomolithes tuberculatus*, Wahlenberg, Nov. Act. Upsala, vol. viii, pp. 6, 31.
1822. *Calymene blumenbachi*, Brongniart, Hist. Nat. Crust. Foss., p. 11, pl. i, figs. 1 *a*—*c*.
1826. *Calymene tuberculata*, Dalman, Palæad., p. 227, pl. i, figs. 3 *a*—*c*.
? 1837. *Calymene blumenbachi*, Hisinger, Leth. Suec., p. 10, pl. i, figs. 4 *a*, *b*.
1839. *Calymene blumenbachii*, Murchison, Silur. Syst., p. 653, pl. vii, figs. 6, 7 (*non* fig. 5).
1843. *Calymene blumenbachi*, Burmeister (*e. p.*), Organ. Trilob., p. 96, pl. ii, figs. 1—3.
1854. *Calymene blumenbachi*, M'Coy (*e. p.*), Synops. Pal. Foss. Woodw. Mus., p. 165.
— *Calymene subdiademata*, M'Coy (*e p.*), ibid., p. 166, pl. i F, figs. 9, 9 *a* (*non* figs. 10, 10 *a*).
— *Calymene tuberculata*, Angelin (*e. p.*), Pal. Scand., p. 29, pl. xix, fig. 5 *a* (*non cet.*).
? 1857. *Calymene blumenbachi*, Nieszkowski, Archiv Naturk Liv.-Est.-Kurl., ser. i, vol. i, p. 541.
1865. *Calymene blumenbachii*, Salter, Mon. Brit. Trilob., p. 93, pl. viii, figs. 7—16; pl. ix, figs. 1, 2.
1873. *Calymene blumenbachii*, Salter (*e. p.*), Cat. Camb. Silur. Foss. Woodw. Mus., pp. 77, 132.
1875. *Calymene blumenbachii*, Baily, Char. Brit. Foss., p. 67, pl. xxiii, figs. 1 *a*, *b*.
1877. *Calymene blumenbachi*, Woodward (*e. p.*), Cat. Brit. Foss. Crust., p. 28.
1879. *Calymene blumenbachii*, Nicholson and Etheridge (*e. p.*), Mon. Silur. Foss. Girvan, fasc. ii, p. 140, pl. x, fig. 6 (*non* figs. 2—5).
1885. *Calymene tuberculata*, Lindström, Förteckn. Gotl. Silur. Crust., p. 63, pl. xvi, fig. 9.
? 1890. *Calymene tuberculata*, Pompecki, Trilobitf. Ost. u. West-preuss. Diluv. Geschieb. (Beitr. Naturk. Preuss. Phys. Oek. Gesell. Königsberg), p. 40, pl. vi, fig. 19.
? 1894. *Calymmene tuberculata*, Schmidt, Rev. Ostbalt. Silur. Trilob., pt. iv, p. 13, pl. i, figs. 1—7.
1899. *Calymene blumenbachi*, Mem. Geol. Surv., Silur. Rocks Brit., vol. i, Scotland, pp. 529, 530, 536, 540, 543, 550 (*non* p. 524).

Remarks.—It has been possible with the aid of the abundant material from Girvan and in the light of the suggestions put forward by Pompecki[1] to separate several distinct species from those grouped together by Nicholson and Etheridge as *C. blumenbachi*. The typical *C. blumenbachi*, however, does occur in the Girvan area, though apparently it is limited to the Silurian. One example from Mulloch was figured by Nicholson and Etheridge (*op. cit.* pl. x, fig. 6). The distinctive features of the Ordovician species hitherto associated with *C. blumenbachi* are given below. The large overhanging and more or less swollen frontal lobe of the glabella and the reduced size of the first lateral lobes are marked characteristics of the Silurian form.

A possible variety with a somewhat angulated anterior margin and a longer and narrower glabella occurs in Mrs. Gray's collection from Newlands (Pl. XVII, fig. 13).

Collections.—Mrs. Gray (f. M.); Museum of Practical Geology; Edinburgh Museum; Woodwardian [Sedgwick] Museum.

Horizons and Localities.—Mulloch Hill Group (L. Llandovery): Mulloch Hill. Saugh Hill Group (M. Llandovery): Newlands; Woodland Point; Craigens. Penkill Group (Tarannon): Penkill.

[1] Pompecki, 'Neues Jahrb. für Miner.,' 1898, vol. i, p. 197.

1 *a*. **Calymene blumenbachi**, auct., var. nov. **drummuckensis.** Plate XVII, fig. 14; plate XVIII, figs. 1—4.

1851. *Calymene blumenbachii*, Salter, Quart. Journ. Geol. Soc., vol. vii, p. 172, pl. ix, figs. 1 *a*, 1 *b*.
1854. *Calymene blumenbachi*, M'Coy (*e. p.*), Synops. Pal. Foss. Woodw. Mus., p. 165.
1873. *Calymene blumenbachii*, Salter (*e. p.*), Cat. Camb. Silur. Foss. Woodw. Mus., p. 77.
1879. *Calymene blumenbachi*, Nicholson and Etheridge (*e. p.*), Mon. Silur. Foss. Girvan, fasc. ii, p. 140, pl. x, figs. 2—5 (*non* fig. 6).
1899. *Calymene blumenbachi*, Mem. Geol. Surv., Silur. Rocks Brit., vol. i, Scotland, pp. 524, 526 (*non cet.*).

Remarks.—The specimens from the Drummuck beds attributed to *C. blumenbachi* by Nicholson and Etheridge (*loc. cit.*) are quite distinct from the typical Wenlock form, as the examination of a large series of specimens indicates. They cannot, however, be referred to either of the varieties *allportiana*, Salter, or *caractaci*, Salter, though they are somewhat allied to the latter; and they are also separable from *C. senaria*, Salter (*e. p.*) (= *planimarginata*), on account of the strongly-raised, rounded, frontal border as well as other features.

Description.—The head-shield is parabolic and pointed in front, like *C. caractaci*, but the frontal border forms a strongly-rounded elevated rim as in typical examples of *C. blumenbachi*, and the marginal furrow is deep and narrow, as in *C. senaria*, auct. (*non* Salter). The glabella is longer than wide, but has a broader base than *C. caractaci* owing to the lateral projection of the large basal lobes which are situated more than their diameter apart. The glabella is very slightly contracted in front of them (not so suddenly as in *C. blumenbachi*), the axial furrows bending inwards a little. The posterior lateral furrows are strongly bifurcated inwardly (well seen in casts). The second lateral lobes are rounded and intermediate in size between the anterior and posterior lobes, thus differing from all the types of *C. senaria*. There is a buttress opposite them. The anterior lobes are small but distinct, and are not overhung by the frontal lobe as in *C. blumenbachi*. The frontal lobe is much shorter, narrower, and less swollen than in the typical specimens of the latter. The axial furrows are slightly sigmoidal, not straight as in *C. caractaci*, but agreeing with *C. blumenbachi*. The eye is opposite the second lateral lobe. The fixed cheek has a width along the posterior margin about equal to the basal width of the glabella. The surface of the head is coarsely but uniformly and closely granulated, all the granules being of equal size; and there is a low median tubercle on the neck-ring. In *C. blumenbachi* there are scattered tubercles on the glabella.

There appears to be no distinctive feature in the thorax; and the pygidium is indistinguishable from the typical *C. blumenbachi* which Salter has well illustrated.[1] It may be remarked that the pleuræ do not correspond with the axial rings even at the anterior end of the pygidium. The pleural furrows are only visible

[1] Salter, 'Mon. Brit. Trilob.,' pl. viii, fig. 8 *c*, pl. ix, figs. 1 *b*, 2 *b*.

close to axis and near outer ends of pleuræ. The hypostome of *Calymene* which occurs in the Starfish Bed and may be referred to this variety of *C. blumenbachi*, possesses a few features differing from the typical form. It is wider in front, narrower behind, and altogether more elongate in shape. The posterior margin is more deeply emarginate and the posterior alæ are not so far back. The body is more compressed and elevated, rising regularly to the median tubercle, and the band across the posterior end of the body is only faintly defined.

In spite of the considerable differences in the glabellar lobes and other parts, it seems preferable to regard this form as only a variety of *C. blumenbachi*, though without doubt it is a well-marked one deserving a distinctive name. The designation *C. blumenbachi* var. *drummuckensis* may be accordingly suggested.

Collections.—Mrs. Gray (f. M.); Museum of Practical Geology; Edinburgh Museum; Woodwardian [Sedgwick] Museum; Hunterian Museum.

Horizon and Localities.—Drummuck Group (U. Bala): Drummuck; Thraive Glen (Starfish Bed).

2. **Calymene cambrensis,** Salter, 1865. Plate XVII, fig. 16.

1848. *Calymene brevicapitata,* Salter, Mem. Geol. Surv., vol. ii, pt. i, pl. xi, fig. 3 (? figs. 4, 5).
1854. *Calymene brevicapitata,* M'Coy, Synops. Pal. Foss. Woodw. Mus., p. 165, pl. i F, figs. 4, 5 (*non* fig. 6).
1865. *Calymene blumenbachi,* var. *cambrensis,* Salter, Mem. Geol. Surv., vol. iii, pl. xvii, figs. 13, 14.
1865. *Calymene cambrensis,* Salter, Mon. Brit. Trilob., p. 98, pl. ix, figs. 12—14.
1873. *Calymene cambrensis,* Salter, Cat. Camb. Silur. Foss. Woodw. Mus., p. 33.
1877. *Calymene cambrensis,* Woodward, Cat. Brit. Foss. Crust., p. 28.
1879. *Calymene blumenbachi,* Nicholson and Etheridge (*e. p.*), Mon. Silur. Foss. Girvan, fasc. ii, p. 140 (*non* pl. x, figs. 2—6).

Remarks.—There exists, unfortunately, a state of great confusion and uncertainty in connection with most of the British Ordovician species of *Calymene*. Pompecki[1] has recently attempted to introduce some definiteness into our conceptions of the various species, but perhaps not with complete success, and this is not the place for a thorough revision of the species. Nicholson and Etheridge put all the Girvan Ordovician representatives of the genus into the species *C. blumenbachi*, as above recorded, and enlarged the synonymy of that species accordingly, but this is a course which I cannot consider justified. Only the Silurian forms of *Calymene* in the Girvan area may, in my opinion, be attributed to the true *C. blumenbachi*, and they are distinct from the Ordovician, amongst which may be recognised in this area three separate species—*C. cambrensis*, Salter, *C. planimarginata*, sp. nov., and the Drummuck variety of *C. blumenbachi* which has been above described.

The species *C. cambrensis* is characterised by its glabella being parabolic, short and broad, with convex sides, not contracted in front of the basal lobes; by its three

[1] Pompecki, 'Neues Jahrb. für Miner.,' 1898, vol. i, p. 187.

pairs of graduated lobes, the basal ones not showing such a great increase in size over the second as in *C. senaria*, auct.; by its wide, flattened, slightly upturned frontal border; and by its short frontal lobe. The posterior lateral furrow bifurcates inwardly, as in *C. senaria*, auct. The axial furrows are not sigmoidal in their course, but gently arched outwards.

There are well-marked but poorly preserved specimens from Craighead in Mrs. Gray's collection. The pygidium, of which there are also specimens from Craighead, is more pointed posteriorly, longer, and less transverse than in *C. blumenbachi*.

Collections.—Mrs. Gray; Museum of Practical Geology.

Horizons and Localities.—Stinchar Limestone Group (Llandeilo): Craighead. ? Balclatchie Group (Llandeilo): Ardmillan Brae.

3. **Calymene planimarginata,** sp. nov. Plate XVII, fig. 15.

? 1843. *Calymene brevicapitata,* Portlock, Geol. Rep. Londond., pl. iii, fig. 3.
? 1848. *Calymene brevicapitata,* Salter, Mem. Geol. Surv., vol. ii, pt. i, p. 341, pl. xi, figs. 1, 2.
? 1854. *Calymene brevicapitata,* M'Coy, Synops. Brit. Pal. Foss. Woodw. Mus., p. 165, pl. i F, fig. 6.
1854. *Calymene baylei,* M'Coy, ibid., p. 165, pl. i F, figs. 8, 8 *a*, 8 *b*.
? 1854. *Calymene brevicapitata,* Morris, Cat. Brit. Foss., 2nd ed., p. 102.
1865. *Calymene senaria,* Salter (*e. p.*), Mon. Brit. Trilob., p. 97, pl. ix, figs. 8, 10, 11 (*non* figs. 9, ? 6, ? 7).
1877. *Calymene senaria,* Woodward (*e. p.*), Cat. Brit. Foss. Crust., p. 29.
1879. *Calymene blumenbachi,* Nicholson and Etheridge (*e. p.*), Mon. Silur. Foss. Girvan, fasc. ii, p. 140 (*non* pl. x, figs. 2—6).
1898. *Calymene senaria* (Salter, *non* Conrad), Pompecki, Neues Jahrb. für Miner., vol. i, p. 197.
1899. *Calymene blumenbachi* (*e. p.*), Mem. Geol. Surv., Silur. Rocks Brit., vol. i, Scotland, pp. 518, 672, 688.

Specific Characters.—This species is easily distinguished from *C. blumenbachi*, auct., by the shape of the glabella, the small frontal lobe, the flattened, instead of rounded, frontal border and the granulose, instead of tuberculated, surface. It agrees with *C. caractaci*, Salter, in the shape and nature of the frontal border, but differs in the shape of the glabella and lateral lobes.

Remarks.—The species called "*C. senaria*, Conrad," by Salter is a composite one, as Pompecki has pointed out. Of the figures given by Salter (*op. cit.*) only fig. 9 on pl. ix can be considered as representing the *C. senaria*, auct., as held by Emmons, Hall, Meek, and White, though Pompecki is in doubt whether it is really the same form as Conrad meant. Salter's fig. 9, pl. ix (*op. cit.*), was drawn from a Trenton Limestone specimen. The other figures given by Salter of *C. senaria* (pl. ix, figs. 6—8, 10, 11) represent British individuals; of these figs. 6 and 7 are the original figured specimens of *C. brevicapitata*, Portlock,

from Tyrone, while figs. 8, 10, and 11 illustrate Welsh specimens. There is some doubt in my mind whether the specimens shown in figs. 6 and 7 belong to one and the same species; for the frontal border of the head-shield is rounded in one (fig. 6) and flattened in the other (fig. 7), while the relative sizes of the glabellar lobes also differ. The Welsh specimens, however, agree in the flattened or concave upturned frontal border, in the basal width of the glabella being greater than or equal to the length, in the large size and lateral projection of the basal lobes, in the relatively small size of the second lateral lobes, in the contraction of the glabella immediately in front of the basal lobes, in the comparatively short frontal lobe, in the bifurcation of the posterior pair of lateral furrows, in the axial furrows being sigmoidal in course (though only slightly so), in the eyes being a little in front of the second lateral lobes, in the triangular, rather than transversely quadrate, form of the pygidium, and in the granulose surface (according to Salter).

Since the name *senaria* is not available for this form, that of *planimarginata* is here suggested.

Collection.—Mrs. Gray; Museum of Practical Geology.

Horizon and Locality.—Whitehouse Group (M. Bala): Shalloch Mill.

4, 5. **Calymene,** sp. ind. (*a*) and (*b*).

Remarks.—Two minute and imperfect head-shields of species of *Calymene* are in Mrs. Gray's collection from the Balclatchie Conglomerate. Neither is sufficiently well preserved to determine or describe the species; but they appear to belong to different species, one (sp. ind. *a*) with a long narrow glabella reaching the narrow, convex, rounded border, and the other (sp. ind. *b*) with a broader, shorter glabella having a rather swollen, broad, frontal lobe strongly elevated above the narrow, feebly-rounded border. The head-shield of sp. *a* measures 3 mm. in length and that of sp. *b* 5 mm. in length.

Collection.—Mrs. Gray.

Horizon and Locality.—Balclatchie Group (Llandeilo): Balclatchie Conglomerate.

Family CHEIRURIDÆ.

Genus **CHEIRURUS,** Beyrich.

1. **Cheirurus bimucronatus** (Murchison), 1839. Plate XIX, fig. 15.

1839. *Paradoxides bimucronatus*, Murchison, Silur. Syst., p. 658, pl. xiv, figs. 8, 9.
1840. *Paradoxides bimucronatus*, Milne Edwards, Crust., vol. iii, p. 343.

1840. *Calymene speciosa*, Hisinger, Leth. Suec., 2nd suppl., pl. xxxix, fig. 2.
1843. *Arges bimucronatus*, Goldfuss, Neues Jahrb., p. 544.
1845. *Cheirurus bimucronatus*, Beyrich, Ueber böhm. Trilob., pp. 18, 19.
— *Cheirurus insignis*, Beyrich, ibid., fig. i 1.
? 1846. *Cheirurus insignis*, Barrande, Not. prélim., p. 49.
1848. *Cheirurus speciosus*, Salter, Mem. Geol. Surv., vol. ii, pt. i, p. 345, pl. vii, figs. 4—6.
1849. *Ceraurus williamsii*, M'Coy, Ann. Mag. Nat. Hist. [2], vol. iv, p. 408.
1851. *Cheirurus bimucronatus*, Salter, Quart. Journ. Geol. Soc., vol. vii, p. 172.
? 1851. *Cheirurus speciosus*, Angelin, Pal. Scand., p. 78, pl. xxxix, fig. 14; pl. xli, fig. 15.
? 1852. *Cheirurus insignis*, Barrande, Syst. Silur. Bohême, vol. i, p. 782, pl. xli, figs. 1—13.
1853. *Cheirurus bimucronatus*, Salter, Mem. Geol. Surv., dec. vii, pl. ii.
1854. *Ceraurus williamsii*, M'Coy, Synops. Brit. Pal. Foss. Woodw. Mus., p. 155, pl. i F, fig. 13.
— *Cheirurus bimucronatus*, Morris, Cat. Brit. Foss., 2nd ed., p. 103.
1864. *Cheirurus bimucronatus*, Salter, Mon. Brit. Trilob., p. 63, pl. v, figs. 1—5; pl. vi, figs. 9—18.
1866. *Cheirurus bimucronatus*, Salter, Mem. Geol. Surv., vol. iii, p. 323, pl. xviii, figs. 4—6.
1867. *Cheirurus bimucronatus*, Murchison, Siluria, 4th ed., pl. iii, fig. 5; pl. xix, figs. 10, 11.
1873. *Cheirurus bimucronatus*, Salter, Cat. Camb. Silur. Foss. Woodw. Mus., pp. 77, 86, 130.
1876. *Cheirurus bimucronatus*, Armstrong and Young, Cat. West. Scot. Foss., p. 15.
1877. *Cheirurus bimucronatus*, Woodward, Cat. Brit. Foss. Crust., p. 30.
1878. *Cheirurus bimucronatus*, Nicholson and Etheridge (*e. p.*), Mon. Silur. Foss. Girvan, fasc. i, p. 100.
1879. *Cheirurus bimucronatus*, Nicholson and Etheridge, ibid., fasc. ii, p. 202, pl. xiv, fig. 9.
1884. *Chirurus speciosus*, Törnquist, Siljans. Trilobitf. (Sver. Geol. Undersökn., ser. C, no. 66), p. 12.
? 1884. *Chirurus insignis*, Törnquist, ibid., p. 12, pl. i, fig. 9.
1885. *Chirurus bimucronatus*, Lindström, Förteckn. Gotl. Silur. Crust., p. 45.
— *Chirurus speciosus*, Lindström, ibid., p. 44, pl. xii, fig. 11.
1899. *Cheirurus bimucronatus*, Mem. Geol. Surv., Silur. Rocks Brit., vol. i, Scotland, pp. 524, 532, 538, etc.
1900. *Chirurus bimucronatus*, Wiman, Bull. Geol. Instit. Upsala, no. 10, vol. v, pt. ii, p. 169.

Remarks.—This species occurs in both the Ordovician and Silurian beds of the Girvan district. Nicholson and Etheridge's figured specimen (*op. cit.*, pp. 100, 202, pl. xiv, fig. 9) came from Drummuck. Some unusually large specimens come from Thraive Glen, and are in Mrs. Gray's collection; one of these has a glabella measuring at least 42 mm. in length and a thorax over 65 mm. in width.

A pygidium, probably attributable to this species, from Newlands (Mrs. Gray's collection), is remarkable for the great development of the first pair of pleuræ, which reach back as free spines to double the length of the pygidium, while the second and third pairs are only of moderate length, and the members of the latter pair are in contact in the middle line, there being no central terminal point to the pygidium. A similar pygidium has been noticed by me from Woodland Point, but this has a very short central terminal point. There is considerable variation in the relative size of the pleuræ of the pygidium and in the length of the spines amongst typical Wenlock examples in England; but the excessive development of the first pair of pleuræ recalls *C. exsul*, Beyr., and *C. gladiator*, Eichw.

Collections.—Mrs. Gray; Edinburgh Museum (f. M.); Museum of Practical Geology; Woodwardian [Sedgwick] Museum.

Horizons and Localities.—Drummuck Group (U. Bala): Drummuck; Thraive Glen. Saugh Hill Group (M. Llandovery): Newlands; Woodland Point. Camregan Group (U. Llandovery): Penwhapple Glen; Bargany Pond Burn.

2. **Cheirurus gelasinosus** (Portlock), 1843. Plate XVIII, figs. 5, 6.

1843. *Amphion gelasinosus*, Portlock, Geol. Rep. Londond., p. 289, pl. iii, fig. 4.
— *Arges planospinosus*, Portlock, ibid., p. 272, pl. v, fig. 9.
1845. *Cheirurus gelasinosus*, Beyrich, Ueber böhm. Trilob., pt. i, p. 19.
1851. *Cheirurus gelasinosus*, Salter, Quart. Journ. Geol. Soc., vol. vii, p. 170, pl. viii, fig. 1.
1853. *Cheirurus gelasinosus*, Salter, Mem. Geol. Surv., dec. vii, art. 2, p. 11.
1859. *Cheirurus gelasinosus*, Murchison, Siluria, 2nd ed., p. 538.
1864. *Cheirurus gelasinosus*, Salter, Mon. Brit. Trilob., p. 71, pl. v, figs. 6—8.
1876. *Cheirurus gelasinosus*, Armstrong and Young, Cat. West. Scot. Foss., p. 15.
1877. *Cheirurus gelasinosus*, Woodward, Cat. Brit. Foss. Crust., p. 30.
1879. *Cheirurus gelasinosus*, Nicholson and Etheridge (*e. p.*), Mon. Silur. Foss. Girvan, fasc. i, p. 100 (*non* pl. vii, figs. 5, 6).
1899. *Cheirurus gelasinosus*, Reed, Quart. Journ. Geol. Soc., vol. lv, p. 748.

Remarks.—Though the head-shields attributed to this species by Nicholson and Etheridge (*op. cit.*) belong to the subgenus *Nieszkowskia* (p. 142) and are quite distinct from the true *C. gelasinosus*, yet the latter species really occurs in the limestone of Craighead, and also of Minuntion. Salter in 1851 (*loc. cit.*) gave a good figure of a head-shield of this species from Craighead. The Russian species *C. exsul*, *C. spinulosus*, and *C. gladiator*, which come from approximately the same stratigraphical horizon, have very similar head-shields, and are closely allied forms.

There is a portion of the thorax of a large *Cheirurus* from Craighead which belongs presumably to this species, as it is of the right size and proportions to fit the head-shield. But the thorax of *C. gelasinosus* has not been previously described. This specimen shows a convex cylindrical axis about two thirds the width of the pleuræ, which consist of an inner straight portion traversed by a short oblique furrow, and of an outer, rounded, and unfurrowed, gently curved portion, tapering to a free point. The base of this outer portion is somewhat swollen, and at its junction with the inner portion the pleura is constricted, and it is here that the fulcrum is situated. The tubercle situated at this point in *C. bimucronatus* is not apparent, perhaps owing to the state of preservation, but in other respects the thoracic rings appear to be almost indistinguishable from those of this species.

Some fragments of head-shields from the Balclatchie conglomerate, which are in Mrs. Gray's collection, may belong to this species.

Collections.—Mrs. Gray; Museum of Practical Geology.

Horizon and Localities.—Stinchar Limestone Group (Llandeilo): Craighead; Minuntion. ? Balclatchie Group (Llandeilo): Balclatchie Conglomerate.

2 *a*. **Cheirurus gelasinosus** (Portlock), var. Plate XVIII, fig. 7.

Description.—There is a small glabella from Balclatchie in the Museum of Practical Geology which is seen to differ from *C. gelasinosus*, Portlock, in several particulars when closely examined. The glabella is subquadrate in shape, nearly as wide as long, and slightly expanding towards the front; the sides are nearly parallel. There are three pairs of lateral furrows, all rather long and extending more than one third of the distance across the glabella. The first pair is very far forward, starting from the anterior lateral angles and sloping backwards obliquely; the second pair is at the middle of the glabella, and the furrows are straight and horizontal; the third pair is about half way between the second pair and the occipital furrow, and the furrows are oblique and curved, almost enclosing the triangular basal lobes. The occipital segment is narrower than the lateral lobes, and bears a median tubercle. The axial furrows are deep, straight, and nearly parallel. There is a narrow, rounded, frontal border before the glabella. The surface of the glabella is evenly granulated, but not tuberculated.

Dimensions.—

Length of glabella . . .	10·0 mm.
Width ,, ,, . . .	8·0 ,,

Remarks.—This form differs from *C. gelasinosus* in the granulated, non-tuberculated surface, the more forward position of the first lateral furrows, the different directions of the three pairs of lateral furrows, and the narrower neck-ring. It is certainly distinct from the Craighead type of *C. gelasinosus*, and the non-parallelism of the lateral furrows marks it off from Portlock's Tyrone examples.

Collection.—Museum of Practical Geology.

Horizon and Locality.—Balclatchie Group (Llandeilo): Balclatchie.

3. **Cheirurus (Cyrtometopus) octolobatus** (M'Coy), 1849. Plate XVIII, figs. 8—11.

1849. *Sphærexochus juvenis* (*e. p.*), Salter, Mem. Geol. Surv., vol. ii, pt. i, p. 344, pl. vii, fig. 3 *b* (*non* figs. 1, 1 *a*, 2, 3, 3 *a*).

1849. *Ceraurus octolobatus*, M'Coy, Ann. Mag. Nat. Hist. [2], vol. iv, p. 407.

1851. *Ceraurus octolobatus*, M'Coy, Synops. Pal. Foss. Woodw. Mus., p. 154, pl. i G, fig. 10.

1853. *Cheirurus octolobatus*, Salter, Mem. Geol. Surv., dec. vii, art. 2, p. 11.

1854. *Ceraurus octolobatus*, M'Coy, Contrib. Brit. Pal., p. 146.

1864. *Cheirurus* (*Actinopeltis*) *octolobatus*, Salter, Mon. Brit. Trilob., p. 69, pl. v, figs. 13, 14.

1866. *Cheirurus octolobatus*, Salter, Mem. Geol. Surv., vol. iii, p. 323, pl. xviii, fig. 3.
1873. *Cheirurus octolobatus*, Salter, Cat. Camb. Silur. Foss. Woodw. Mus., p. 51.
1876. *Cheirurus clavifrons*, Armstrong and Young, Cat. West. Scot. Foss., p. 15.
1877. *Cheirurus* (*Actinopeltis*) *octolobatus*, Woodward, Cat. Brit. Foss. Crust., p. 31.
1878. *Cheirurus clavifrons* (?), Nicholson and Etheridge, Mon. Silur. Foss. Girvan, fasc. i, p. 101, pl. vii, figs. 7, 8, ? 9; and fasc. ii, p. 202, pl. xiv, fig. 10.
1891. *Cheirurus* (*Actinopeltis*) *octolobatus*, Woods, Cat. Type Foss. Woodw. Mus., p. 142.

Remarks.—There exists much doubt whether *C. octolobatus*, M'Coy, is identical with *C. clavifrons*, Dalm.; and as we are not in a position at present to settle the matter it seems safer to keep the British forms apart rather than to assume a possibly non-existent specific identity. Moreover, so far as the Girvan specimens indicate, the eyes are too far back for *C. clavifrons* as interpreted by Schmidt,[1] Brögger,[2] and other continental palæontologists, and the posterior branch of the facial suture diverges at a level between the second and third lateral furrows of the glabella. The anterior part of the head-shield also differs in the amount of bending down.

The pygidia of *C. clavifrons* and of the allied *C. affinis*, Angelin, are of a type quite distinct from that associated with these Girvan head-shields. On the other hand, these Girvan specimens agree minutely in the features of the head-shield, thorax, and pygidium with those figured as *C. octolobatus* by Salter (*op. cit.*, 1864), though some of them are of a larger size, one head-shield measuring 27 mm. in length. It may be remembered that Salter's type of this species (*op. cit.*, pl. v, fig. 13) came from Penwhapple in the Girvan area. There is in Mrs. Gray's collection one excellent specimen of the whole thorax with pygidium attached, showing with great clearness all the characteristic features of the species as described by Salter, except that the axis is rather narrower. The species is rather common in the Sholeshook Limestone of the Haverfordwest district.

Collections.—Mrs. Gray (f. M.); Edinburgh Museum.

Horizon and Localities.—Drummuck Group (U. Bala): Drummuck; Thraive Glen; Penwhapple.

4. **Cheirurus (Nieszkowskia) unicus** (Wyville Thomson), 1857. Plate XVIII, figs. 12—16.

1857. *Acidaspis unica*, Wyville Thomson, Quart. Journ. Geol. Soc., vol. xiii, p. 209, pl. vi, figs. 13, 14.
1857. *Staurocephalus ? maclareni*, Wyville Thomson, MS. (*e. p.*), Coll. Mus. Pract. Geol.
1865. *Staurocephalus ? unicus*, Salter (*e. p.*), Mon. Brit. Trilob., p. 86, pl. vii, figs. 23, 24 (*non* fig. 22).

[1] Schmidt, 'Rev. Ostbalt. Silur. Trilob.,' pt. i, p. 153, pl. viii, figs. 4—6; pl. xvi, figs. 7—12.
[2] Brögger, 'Die Silur. Ét. 2 und 3,' p. 131, pl. v, figs. 1, 2, ? 3.

1865. *Staurocephalus? maclareni*, Salter, ibid., p. 86.
— *Staurocephalus? unicus*, Salter (*e. p.*), Mem. Geol. Surv., dec. xi, art. 5.
? 1876. *Staurocephalus? unicus*, Armstrong and Young, Cat. West. Scot. Foss., p. 16.
1877. *Staurocephalus? unicus*, Woodward (*e. p.*), Cat. Brit. Foss. Crust., p. 59.
1878. *Staurocephalus? unicus*, Nicholson and Etheridge (*e. p.*), Mon. Silur. Foss. Girvan, fasc. i, p. 118, pl. viii, figs. 10, 11 (*non* figs. 9, 12—16). [Fig. 11 is the type specimen of *Stauro.? maclareni*, Wyv. Thom. MS., Coll. Mus. Pract. Geol.]
1878. *Cheirurus gelasinosus*?, Nicholson and Etheridge, ibid., p. 100, pl. vii, figs. 5, 6.
— *Staurocephalus maclareni*, Etheridge (*e. p.*), Cat. Camb. Silur. Foss. Mus. Pract. Geol., p. 39.
1899. *Staurocephalus unicus* (*e. p.*), Mem. Geol. Surv., Silur. Rocks Brit., vol. i, Scotland, pp. 509, 674, 689.

Specific Characters.—Head-shield broadly semicircular, nearly three times as broad as long. Glabella broadly oval, truncate at base, strongly convex, rising twice as high as the cheeks; three pairs of lateral furrows, the basal pair strongly oblique and incompletely marking off triangular basal lobes, the two anterior pairs of furrows less oblique, but parallel with one another, the more anterior pair close to the front end of the glabella, and all the furrows extending about one third of the way (or rather less) across the glabella. The basal lobes extend farther along the side of the glabella than the middle or first lateral lobes, and are larger than either. Surface of glabella ornamented with small, irregular, somewhat sparse tubercles. Fixed cheeks gently convex, pitted, more than twice as wide as glabella. Narrow anterior wing present to fixed cheek in front of eye, joining on to smooth, flattened, pre-glabellar border. Eye of moderate size, situated opposite middle lateral lobe or a little behind it. Occipital ring at base of glabella of moderate size, of regular width, marked off by strong furrow. Behind the cheeks the neck-segment widens towards the genal angle, which is produced into a short point. The neck-segment is tuberculated, like the glabella.

Thorax of twelve segments. Axis, strongly convex, narrow, half as wide as pleural portions, cylindrical, very slightly tapering posteriorly. Axial rings simple. Pleuræ horizontally extended, straight as far out as the weak fulcrum which is situated at about two thirds their length; beyond the fulcrum they are gently curved backwards and a little downwards. Each pleura is narrow and of uniform width, except beyond the fulcrum, where it tapers gradually to a pointed extremity; a median longitudinal furrow runs along it, marked with a row of minute pits. A single longitudinal row of small tubercles ornaments the anterior and posterior portions of each pleura.

Pygidium short, broad, with much developed first pair of pleuræ. Axis consists of two complete rings, followed by a triangular piece forming more than half the axis, and bearing an incomplete transverse groove near its anterior end. Axial furrows indistinct, the second axial ring merging into the base of the second pair of pleuræ. Lateral lobes consisting of two pairs of pleuræ, of which the first is much the larger, being produced into long, backwardly directed, and

slightly divergent spines, twice or three times as long as the whole pygidium. The first pair of pleuræ broaden rapidly to the point where they begin to curve back, beyond which they taper into the free spines; a short median furrow marks their basal portion. The second pair of pleuræ are not grooved, are very short and broadly triangular, expanding very rapidly from their narrow base, and uniting behind the axis, so as to form the nearly straight posterior margin of the pygidium. (It is probable that the triangular piece apparently belonging to the axis consists of one axial ring and its corresponding pair of pleuræ fused in the median line.) Surface of pygidium tuberculated like head-shield.

Dimensions.—	I[1]	II
Length of head-shield .	? mm. . .	8·0 mm.
Width ,, ,, .	17·0 ,, . .	24·0 ,,
Length ,, glabella . .	7·5 ,, . .	10·0 ,,
Width ,, ,, (across middle)	6·0 ,, . .	8·5 ,,
Length ,, thorax . .	8·0 ,, . .	10·5 ,,
Width ,, ,, . .	12·5 ,, (crushed) .	24·0 ,,
,, ,, axis . .	2·0 ,, ,, .	5·0 ,,
Length ,, pygidium (without spines)	3·0 ,, . .	—
Width ,, ,, . .	6·5 ,, . .	—

Remarks.—There has been much uncertainty and confusion about this species, which was founded by Wyville Thomson primarily on some pleuræ attached to an imperfect pygidium, and was called *Acidaspis unica*. These pleuræ have a median groove, in which lies a row of pits, as Salter correctly represented in his figure, remarking in the description of the species that this was a character found in the genus *Eccoptocheile*. Nicholson and Etheridge figured a number of specimens under the name *Staurocephalus* ? *unicus* (M., fasc. I, 1878, p. 118, pl. viii, figs. 9–16), but only a few of them can be retained in this species (*i. e.* figs. 10, 11, *non* figs. 9, 12–16). The best figured specimen from Girvan (M., pl. viii, fig. 10) is much more nearly perfect than the figure given by these authors indicates. In this specimen the base of the glabella is preserved, and it shows one pair of very oblique basal furrows incompletely marking off triangular basal lobes. The glabella appears to be of an oval shape. The eye is situated on the pitted cheek at the level of this basal furrow and not far from the axial furrow. The genal angles are provided with short spines, and the occipital segment is rounded and ornamented with a few tubercles. The glabella is ornamented with somewhat sparse small tubercles. The pygidium shows a pair of enormously-developed first pleuræ, grooved near their base; the second pair of pleuræ are very short, broad, triangular, expanded, and abruptly truncated posteriorly, and meeting in the middle line behind the pointed axis. The twelve thoracic rings are not very well shown in this specimen, but fortunately another specimen of an individual, complete on one side, except

[1] This is the specimen figured by Nicholson and Etheridge (*op. cit.*, pl. viii, fig. 10).

the posterior part of the pygidium, and several detached, nearly perfect head-shields and pygidia of identical characters, are known from the same locality, Balclatchie, and provide us with the means of giving the above complete description of the species. The head-shields figured by Nicholson and Etheridge (M., fasc. I, 1878, p. 100, pl. vii, figs. 5, 6) as belonging to *Cheirurus gelasinosus* ? are found to belong to *C.* (*Nieszk.*) *unicus.*

A few remarks are necessary as to the generic position of this species. The characters of the head-shield, the oval glabella without a stalk, and the longitudinally furrowed simple pleuræ of the thorax, are amply sufficient to separate it from *Staurocephalus*, and to suggest its location in *Ecceptocheile* or *Nieszkowskia*. The relations of these subgenera or genera have been discussed by me [1] elsewhere. The view more recently expressed by Raymond [2] that *Nieszkowskia* is a senile expression of *Pseudosphærexochus* does not commend itself to me. The characters of the pygidium decide that this Girvan species should be placed in *Nieszkowskia*. The peculiar oblique basal pair of glabellar furrows are an additional point in favour of this reference, and the resemblance to the species of this subgenus described from the Ordovician Stage C of the Baltic provinces is very striking.[3] The pygidial characters are closely similar; the hugely developed first pair of pleuræ, the much reduced non-furrowed second pair, the axis of two complete rings, with the pointed triangular piece behind marked by an incomplete furrow near its anterior end, are features clearly seen in *N. variolaris*, Linnarsson.[4]

With regard to British forms and the confusion connected with this species, Wyville Thomson's description of his original type specimen is correct so far as it goes. Other specimens collected and similarly named by him which I have examined, make it clear that Salter's figured examples of the pleuræ and pygidium also belong to the same species, and the figures correctly indicate their characters. But the head-shield attributed by Salter (*op. cit.*, pl. vii, fig. 22) to this species does not belong to it, as the complete individuals from Girvan prove. Nicholson and Etheridge (*op. cit.*) have likewise confused two species under this name; their description of *Ch.* (*N.*) *unicus* is therefore faulty, and only some of their figures are of specimens really attributable to it (M, pl. viii, figs. 10, 11, *non* figs. 9, 12—16). Furthermore, the pygidium attached to the pleuræ figured by Salter (*op. cit.*), and to the complete individual figured by Nicholson and Etheridge (M, fig. 10), agrees with the imperfect one from Penwhapple Glen, called by the MS. name *Staurocephalus maclareni* by these authors and figured by them (M, pl. viii, fig. 11). But, on the other hand, the specimens of head-shields labelled *S. maclareni*, MS., by Wyville Thomson and presented by him to the Museum of Practical Geology,

[1] Reed, 'Geol. Mag.' [4], vol. iii (1896), p. 162.

[2] Raymond, 'Ann. Carnegie Mus.,' vol. iii, no. 2 (1905), p. 374.

[3] Schmidt, 'Rev. Ostbalt. Silur. Trilob.,' pt. i, pp. 179—188, pl. ix, figs. 1—16 ; pl. xi, figs. 25—28.

[4] Linnarsson, 'Vestergotl. Camb. Silur. Aflagr,' p. 60, pl. i, fig. 6.

where I have examined them, agree with that figured by Salter erroneously (*op. cit.*, pl. vii, fig. 22) as the head-shield of *St. unicus*. It is not certain whether Wyville Thomson considered the head-shields or the pygidium as the type of his MS. species, *St. maclareni*. As he apparently confused two distinct species under this name by associating a detached pygidium of one (*Ch. unicus*) with the detached head-shield of another (*Sphærocoryphe thomsoni*, sp. nov.), it seems better to let the MS. name *St. maclareni* drop. Fortunately, his type of *Ch. unicus* is clear and sufficient for identification and comparison.

Collections.—Mrs. Gray (f. M.); Museum of Practical Geology; Woodwardian [Sedgwick] Museum; Hunterian Museum.

Horizons and Localities.—Balclatchie Group (Llandeilo): Balclatchie; Penwhapple Glen. ? Balclatchie Conglomerate.

5. **Cheirurus (Sphærocoryphe) thomsoni,** sp. nov. Plate XVIII, fig. 17; Plate XIX, figs. 1—7.

1865. *Staurocephalus ? unicus*, Salter (*e. p.*), Mon. Brit. Trilob., p. 86, pl. vii, fig. 22 (*non* figs. 23, 24).
? 1876. *Deiphon forbesii*, Armstrong and Young, Cat. West Scot. Foss., p. 16.
? — *Staurocephalus unicus*, Armstrong and Young, ibid., p. 16.
1877. *Staurocephalus ? unicus*, Woodward (*e. p.*), Cat. Brit. Foss. Crust., p. 59.
1878. *Staurocephalus maclareni*, Etheridge (*e. p.*), Cat. Camb. Silur. Foss. Mus. Pract. Geol., p. 39.
— *Staurocephalus ? unicus*, Nicholson and Etheridge (*e. p.*), Mon. Silur. Foss. Girvan., fasc. i, p. 118, pl. viii, figs. 9, 12—16 (*non* figs. 10, 11); and p. 120, woodcuts 6 A, B.
1899. *Staurocephalus unicus* (*e. p.*), Mem. Geol. Surv., Silur. Rocks Brit., vol. i, Scotland, pp. 509, 674, 689.

Specific Characters.—Head-shield transverse, broadly semicircular, with prominent glabella, consisting of large, swollen, subglobular anterior portion overhanging front margin, and about one third the width of the head-shield, supported by short, narrow neck, much depressed, with one pair of small lateral nodular lobes. Surface of glabella finely tuberculate. Axial furrows deep. Fixed cheeks triangular, convex, but much lower than globular portion of glabella; surface pitted. Narrow, smooth, lateral border to fixed cheek, with lateral edge furnished with two short obtuse spines. Occipital segment narrow, smooth. Genal angles furnished with strong curved spines, reaching back to about third thoracic pleuræ. Facial sutures acutely bent, the branches meeting at the eye at an angle of about 60°. Eyes small, prominent, placed far forward, but behind middle of globular portion of glabella. Free cheeks very small, triangular, placed on the front margin of the head-shield.

Thorax of ten segments; axis cylindrical, convex, about half as wide as pleural portions. Pleuræ gently curved downwards and backwards; inner portion straight, semicylindrical, feebly convex, but suddenly raised at fulcrum into a

nodular swelling and constricted transversely just beyond. Fulcrum situated at rather less than half the length of pleura. Extra-fulcral portion of pleura depressed, semicylindrical, curved backwards, and ending in free point. Facets for articulation present on inner portion of pleura. The last body-ring appears to be fused with the front of the pygidium in adult individuals, and to have its pleuræ rather broader and shorter. Surface of thorax granulated.

Pygidium short, broad; central portion consisting of a wide, ill-defined, conical axis, composed of three prominent rings and a small posterior piece. Axial furrows nearly obsolete. One pair of huge pleuræ, with broad bases embracing the whole side of the axis, and forming the lateral lobes, produced backward into broad, divergent spines more than twice the length of the pygidium. The base of these pleuræ extends along the whole lateral border of the pygidium, the posterior border between them being simply rounded and arched backward gently. There is no second pair of pleuræ. A faint median longitudinal groove is seen on the basal portion of the pair of pleuræ, and the more distal portion is weakly angulated longitudinally. On both sides of the axis, in the axial furrows, are situated three pairs of deep pits, corresponding with and at the ends of the intersegmental furrows across the axis. Surface of pygidium (including spines) finely granulated.

Remarks.—The head-shield of this species was figured by Salter (*op. cit.*, pl. vii, fig. 22) as belonging to *Staurocephalus unicus*, Wyv. Thomson, but two crushed head-shields from Piedmont Glen presented by Wyville Thomson to the Museum of Practical Geology as examples of his MS. species *Staurocephalus maclareni* are apparently identical. The pygidium, however, in the same collection, labelled also by Wyville Thomson as belonging to the same species, has been shown above not to belong to these head-shields, but to be really attributable to *Ch.* (*Nieszk.*) *unicus*, sens. str. It is doubtful, therefore, on which specimen he founded his MS. species. The head-shields figured by Nicholson and Etheridge (M., fasc. I, 1878, pl. viii, figs. 9, 12–16, *non.* figs. 10, 11) as *Staurocephalus unicus* are almost identical with that figured by Salter. These authors also examined Wyville Thomson's specimens mentioned above, and state that the two head-shields from Piedmont Glen fully bear out Salter's view of the identity of *S. unicus* with *S. maclareni.* It appears, therefore, desirable, in the presence of all this confusion, to give a new name (*Sph. thomsoni*) to these head-shields, especially as we have now found also the thorax and pygidium attached to the head in complete individuals. The specimen of a pygidium from Shalloch Mill, figured in a woodcut by Nicholson and Etheridge (M, p. 120, woodcuts 6 A, B) as "*Staurocephalus ? unicus*, possibly a variety of it, or a new species," is also referable to this species.

There is a fairly distinct variety of this species from the Balclatchie Group, the head-shield of which was figured by Nicholson and Etheridge, as above stated. In this the globular portion of the glabella scarcely overhangs the front margin, but is pressed back, so as almost to conceal the basal nodules (which are much

reduced) and the neck. In other respects these head-shields do not offer any marked or constant points of difference from the Drummuck examples, and the pygidia are indistinguishable. The shape and relations of the glabella resemble *Sphærocoryphe hubneri*, Schmidt,[1] but this species has no lateral spines on the margin of the cheeks. *S. granulatus*, Angelin,[2] which also bears much resemblance, has only one lateral spine instead of two. The Balclatchie specimens are generally of smaller size than the others, but whether they are a distinct variety or species is doubtful, owing to the absence of satisfactory material.

The type form comes from Thraive Glen and the Starfish Bed, and is closely allied to *Sphærocoryphe dentata*, Ang., *S. granulata*, Ang., and *S. cranium*, Nieszk. The characters of the head-shield of *Sphærocoryphe* separate it from the genus *Staurocephalus*, sens. str., and those of its pleuræ from *Nieszkowskia*. The extraordinary development of the first and only pair of pygidial pleuræ recalls the condition of *Deiphon forbesi*, in which the lateral lobes of the pygidium have likewise disappeared.

Collections.—Mrs. Gray (f. M.); Museum of Practical Geology; Edinburgh Museum; Woodwardian [Sedgwick] Museum.

Horizons and Localities.—*Type form.* Drummuck Group (U. Bala): Thraive Glen; Drummuck; (and Starfish Bed). Whitehouse Group (M. Bala): Shalloch Mill. *Variety.* Balclatchie Group (Llandeilo): Balclatchie; Dow Hill.

6. **Cheirurus (Youngia) trispinosus,** Young, 1868. Plate XIX, figs. 8—12.

1868. *Cheirurus trispinosus*, Young, Proc. Nat. Hist. Soc. Glasgow, vol. i, p. 169, pl. i, figs. 4, 6 *b*.
1876. *Cheirurus trispinosus*, Armstrong and Young, Cat. West. Scot. Foss., p. 15.
1878. *Cheirurus trispinosus*, Etheridge, jun., Proc. Roy. Phys. Soc. Edinb., vol. iv, p. 173.
— *Cheirurus trispinosus*, Nicholson and Etheridge, Mon. Silur. Foss. Girvan., fasc. i, p. 105, pl. vii, figs. 10—17.
1885. *Youngia trispinosa*, Lindström, Förteckn. Gotl. Silur. Crust. (Ofv. K. Vet. Akad. Förhandl., no. 6), p. 49.
1898. *Youngia trispinosa*, Reed, Geol. Mag. [4], vol. v, p. 212.
1899. *Cheirurus trispinosus*, Mem. Geol. Surv., Silur. Rocks Brit., vol. i, Scotland, pp. 672, 688.

Specific Characters.—Head-shield probably semicircular in shape, with long spines to genal angles. Glabella subcircular, strongly convex, truncated posteriorly by occipital furrow, slightly overhanging in front, nearly three fifths the total width of the head-shield (without the spines), and as broad as long. Three pairs of lateral furrows present; anterior pair short, shallow, inconspicuous, and far forward; middle pair well marked, curved back, oblique, extending over about one third the width of the glabella on each side; posterior or basal pair deeper

[1] Schmidt, 'Rev. Ostbalt. Silur. Trilob.,' pt. i, p. 168, pl. viii, figs. 11, 12.

[2] Angelin, 'Pal. Scand.,' p. 76, pl. xxxix, fig. 4; and Schmidt, *op. cit.*, p. 169, pl. viii, figs. 17—19.

than the others, curving strongly backwards and becoming weaker before uniting with occipital furrow, so as to mark off transversely oval basal lobes, each more than one third the basal width of the glabella. Occipital furrow well marked, nearly straight, separating off prominent occipital segment, which is rounded and produced behind medianly into a strong, curved, nuchal spine. Axial furrows deep. Fixed cheeks small, short, narrow, less than one third the width of the glabella, bent down on each side, with broad rounded border defined by strong marginal furrow, and with genal angles furnished with long, rounded, divergent, tapering spines, curved downwards like the nuchal spine. Facial sutures cutting outer margin of head-shield at level of basal furrows of glabella and at right angles to axial furrows. Anterior wing of fixed cheeks very narrow and flattened. Free cheeks subtriangular; eye small, prominent, conical; border broad rounded. Surface of head-shield and spines ornamented with coarse tubercles, intermixed with smaller ones irregularly distributed. Extremities of spines longitudinally striated.

Axis of thorax broad, convex. First axial ring furnished with pair of small lateral processes on anterior margin. Surface of ring divided into smooth, posterior, semilunar portion (for enrolment), and raised anterior portion furnished along its posterior edge with single row of small tubercles. Remainder of thorax and pygidium unknown.

Remarks.—The name *Youngia* was proposed by Lindström (*op. cit.*, p. 50) in 1885 as a generic designation for this and two allied species. Unfortunately, our knowledge of it is scanty, the material being imperfect or fragmentary. Nicholson and Etheridge (*op. cit.*, p. 105) do not give a very satisfactory account of the specific characters, but I have now been able to add a description of the free cheek and of a thoracic ring, as well as to supplement that of the glabella and fixed cheek. Though this genus has so far only been found in the Silurian in Scotland and Gotland, yet in the Urals Tschernyschew[1] has described a species (*Y. uralica*) from the Lower Devonian.

Collections.—Mrs. Gray; Museum of Practical Geology; Hunterian Museum, Glasgow.

Horizon and Locality.—Penkill Group (Tarannon): Penkill.

7. **Cheirurus,** subgen. et sp. ind. (*a*). Plate XIX, fig. 13.

From Dow Hill there are two small hypostomes in Mrs. Gray's collection which may belong either to *Ch.* (*Nieszk.*) *unicus* or to *Ch.* (*Sphæro.*) *thomsoni*, var. They possess a convex elliptical body, separated by a deep groove from a narrow rounded border embracing the sides and posterior end, nearly rectangular at

[1] Tschernyschew, 'Mém. Com. Géol. St. Petersb.,' vol. iv, no. 3 (1893), pl. i, fig. 5.

the posterior lateral angles, and deeply notched on each side anteriorly. A very narrow band also runs round the front end of the body, but no lateral wings are preserved.

Collection.—Mrs. Gray.

Horizon and Locality.—Balclatchie Group (Llandeilo): Dow Hill.

8. **Cheirurus,** subgen. et sp. ind. (*b*). Plate XIX, fig. 14.

A slightly different type of Cheirurid hypostome occurs at Balclatchie, and is represented in Mrs. Gray's collection. Its true specific reference is doubtful. The body is subconical and convex, bluntly pointed behind, with a pair of oblique lateral furrows close to the posterior end and nearly meeting in the middle. A small median tubercle is situated on the granulated surface of the body. A narrow band surrounds the anterior end, but a swollen rounded border runs round the sides and posterior end; the border is deeply notched on each side at the front, and is separated sharply from the body.

Collection.—Mrs. Gray.

Horizon and Locality.—Balclatchie Group (Llandeilo): Balclatchie.

Genus **DEIPHON,** Barrande.

1. **Deiphon forbesi,** Barrande, 1850.

1850. *Deiphon forbesi,* Barrande, Haidinger's Berichte, p. 6.
1852. *Deiphon forbesi,* Barrande, Syst. Silur. Bohême, vol. i, p. 814, pl. xxxix, figs. 50, 55.
1854. *Deiphon globifrons,* Angelin, Pal. Scand., p. 66, pl. xxxiv, fig. 7.
— *Deiphon forbesi,* Morris, Cat. Brit. Foss., 2nd ed., p. 106.
1859. *Deiphon forbesi,* Murchison, Siluria, 2nd ed., pp. 262, 539.
1865. *Deiphon forbesi,* Woodward and Salter, Chart Foss. Crust., p. 13.
— *Deiphon forbesi,* Salter, Mon. Brit. Trilob., p. 88, pl. vii, figs. 1—12.
1877. *Deiphon forbesi,* Woodward, Cat. Brit. Foss. Crust., p. 147.
1885. *Deiphon forbesi,* Lindström, Förteckn. Gotl. Silur. Crust. (Ofv. K. Svensk. Vet. Akad. Förhandl., no. 6), p. 51, pl. xiii, figs. 9, 10; pl. xv, figs. 18—20.
1899. *Staurocephalus globiceps,* Mem. Geol. Surv., Silur. Rocks Brit., vol. i, Scotland, pp. 532, 689 (*non Deiphon forbesi,* p. 688).

This species is represented only by a portion of the head-shield and some imperfect thoracic segments from Mulloch Hill. Nicholson and Etheridge were right in denying its occurrence at Balclatchie (M, fasc. i, 1878, p. 121).

Collection.—Mrs. Gray.

Horizon and Locality.—Mulloch Hill Group (L. Llandovery): Mulloch Hill.

Genus **SPHÆREXOCHUS,** Beyrich.

1. **Sphærexochus mirus,** Beyrich, 1845.

1840. *Calymene clavifrons*, Hisinger, Leth. Suec., suppl. ii, pl. xxxvii, fig. 1.
1845. *Sphærexochus mirus*, Beyrich, Ueber böhm. Trilob., p. 21.
1846. *Sphærexochus mirus*, Barrande, Not. prélim., p. 48.
— *Sphærexochus mirus*, Beyrich, Untersuch. üb. Trilob., pt. ii, p. 5, pl. i, fig. 8.
? 1846. *Sphærexochus calvus*, M'Coy, Synops. Silur. Foss. Ireland, p. 44, pl. iv, fig. 10.
1847. *Sphærexochus mirus*, Corda, Prodr. böhm. Trilob., p. 138, pl. vii, fig. 72.
1853. *Sphærexochus mirus*, Barrande, Syst. Silur. Bohême, vol. i, pl. xlii, figs. 11, 18.
— *Sphærexochus mirus*, Salter, Mem. Geol. Surv., dec. vii, pl. iii, figs. 1—15.
1854. *Sphærexochus angustifrons*, Angelin, Pal. Scand., pp. 36, 75, pl. xxii, fig. 8; pl. xxxviii, fig. 16.
— *Sphærexochus mirus*, Morris, Cat. Brit. Foss., 2nd ed., p. 115.
1857. *Sphærexochus mirus*, Nieszkowski, Archiv Naturk. Liv.-Est.-Kurl., ser. i, vol. i, p. 596.
1858. *Sphærexochus mirus*, Schmidt, ibid., p. 189.
1860. *Sphærexochus clavifrons*, Eichwald, Leth. Ross., p. 1401.
1864. *Sphærexochus mirus*, Salter, Mon. Brit. Trilob., p. 76, pl. vi, figs. 1—6.
1873. *Sphærexochus mirus*, Salter, Cat. Camb. Silur. Foss. Woodw. Mus., p. 131.
1875. *Sphærexochus mirus*, Baily, Char. Brit. Foss., p. 40, pl. xiii, figs. 10 *a*, *b*.
1877. *Sphærexochus mirus*, Woodward, Cat. Brit. Foss. Crust., p. 58.
1878. *Sphærexochus mirus*, Nicholson and Etheridge, Mon. Silur. Foss. Girvan, fasc. i, p. 107, pl. vii, fig. 20.
1881. *Sphærexochus angustifrons*, Schmidt., Rev. Ostbalt. Silur. Trilob., pt. i, p. 189, pl. ix, figs. 17 *a*, *b*; pl. xvi, fig. 38.
1884. *Sphærexochus mirus*, Törnquist, Undersökn. Siljans. Trilobitf. (Sver. Geol. Undersökn., ser. C, no. 66), p. 20.
1885. *Sphærexochus mirus*, Lindström, Förteckn. Gotl. Sil. Crust. (Ofv. K. Svensk. Vet. Akad. Förhandl., no. 6), p. 46.
1888. *Sphærexochus mirus*, Wigand, Zeitschr. deutsch. Geol. Gesell., vol. xl, p. 87, pl. x, figs. 13 *a*, *b*.
1899. *Sphærexochus mirus*, Mem. Geol. Surv., Silur. Rocks Brit., vol. i, Scotland, pp. 504, 510, 674, 689.

Remarks.—It has been attempted to separate the Ordovician representatives of this species as distinct, and Schmidt (*op. cit.*, p. 189) accordingly places them with Angelin's species, *S. angustifrons*. The basal lobes are said to be separated by a space equal to only their own diameter, instead of by a space more than half as wide again, as in the Silurian examples. But this distinction seems to break down in the case of the Girvan specimens, for there are glabellas from Craighead with the basal lobes as widely distant as many Silurian examples. It does not therefore seem to be a sufficient character for a specific distinction, the range of variation being wide. It is, however, possible that in the pygidium we may find other

points of difference, as in the case of the Keisley specimens;[1] but this remains to be proved.

Collections.—Mrs. Gray (f. M.); Edinburgh Museum.

Horizons and Localities.—Stinchar Limestone Group (Llandeilo): Craighead; Minuntion; Auchensoul. Balclatchie Group (Llandeilo): Balclatchie (Conglomerate); Dow Hill?

Genus **STAUROCEPHALUS**, Barrande.

1. **Staurocephalus globiceps** (Portlock), 1843.

1843. *Ceraurus globiceps*, Portlock, Geol. Rep. Londond., p. 257, pl. i, fig. 7.

1854. *Staurocephalus globiceps*, Morris, Cat. Brit. Foss., ed. 2, p. 115.

1865. *Staurocephalus globiceps*, Salter, Mem. Geol. Surv., dec. xi, pl. v, fig. 6.

1865. *Staurocephalus globiceps*, Salter, Mon. Brit. Trilob., p. 85, pl. vii, fig. 21 (? woodcut, fig. 18, p. 86).

1877. *Staurocephalus globiceps*, Woodward, Cat. Brit. Foss. Crust., p. 59.

1878. *Staurocephalus globiceps*, Nicholson & Etheridge, Mon. Silur. Foss. Girvan, fasc. i, p. 117.

1899. *Staurocephalus globiceps* (*e. p.*), Mem. Geol. Surv., Silur. Rocks Brit., vol. i, Scotland, pp. 513, 674, 689.

Remarks.—The specimen attributed to this species by Salter and figured by him ('Mon. Brit. Trilob.,' p. 86, fig. 18) is in the Museum of Practical Geology, and came from Ardmillan. Nicholson and Etheridge (M, fasc. i, 1878, p. 117), remark that this figure "does more than justice to the specimen," and such is indeed very much the case. I have grave doubts if it can be attributed to this species. It is in a poor state of preservation, and the glabella is completely destroyed and the pygidium is not preserved; but there are suspicious indications of lateral spines on the margin of the head-shield, and the pleuræ are precisely similar to those of *Sphæro. thomsoni*, with which species it should most probably be placed. The genal spines appear, however, to be rather stouter.

On the other hand, there are fortunately now two good and nearly complete, though small, specimens of *St. globiceps*, collected recently by Mrs. Gray from the Starfish Bed, the identification of which cannot be disputed. They show all the typical characters of the head and thorax as described and figured by Salter, and the pygidium, so far as it is preserved, is likewise identical with the type.

Collections.—Mrs. Gray; Museum of Practical Geology.

Horizons and Localities.—Drummuck Group (U. Bala): Starfish Bed, Thraive Glen. ? Balclatchie Group (Llandeilo): Ardmillan.

[1] Reed, 'Quart. Journ. Geol. Soc.,' vol. lii (1896), p. 423.

Genus **PLIOMERA**, Angelin.

1. **Pliomera** sp. Plate XIX, fig. 16.

Description.—Pygidium subquadrate, but widening a little posteriorly, truncate, strongly convex, and bent down at the sides. Axis conical, reaching about five sixths the length of the pygidium, gently convex; composed of an anterior, rather rapidly tapering portion, consisting of five well-marked rings, and of a posterior, less rapidly tapering, non-annulated portion, of equal length, with pointed extremity and with one median pit near front. Axial furrows well marked. Lateral lobes strongly bent down, consisting of five simple, regular, flattened, unfurrowed pleuræ in close contact, corresponding with the axial rings, gently curved backwards, and ending in bluntly rounded points which project on posterior margin of pygidium. Interpleural furrows sharp and deep. Pleural furrows absent. The last pair of pleuræ bend inwards, meeting and running backwards in contact behind the axis, but separated from one another by a strong interpleural furrow.

Remarks.—It does not appear that this genus has been hitherto detected in the Girvan area; but there are two specimens of pygidia from the Llandeilo of Auchensoul, and another from Tramitchel, which undoubtedly belong to it. One of the Auchensoul specimens measures 8 mm., but the other only 3 mm. in length.

This species differs from all other species of *Pliomera* (= *Amphion* auctt)[1] by possessing a long, posterior, non-ringed axial portion behind the fifth axial ring. In *P. fischeri*[2] this portion is much abbreviated, being no longer than the preceding ring. But in the other characters of the pygidium the Girvan specimens show a close resemblance to this species, the general shape and contour of the pygidium being similar and the number of rings on the axis and of pleuræ on the lateral lobes being identical, and possessing the same features. The previously described British species of the genus, *P. pseudo-articulata* (Portlock),[3] of which the pygidium is known, is quite distinct, the fifth pair of pleuræ being fused completely with the non-ringed portion of the axis behind the fifth axial ring.

Collection.—Mrs. Gray.

Horizon and Localities.—Stinchar Limestone Group (Llandeilo): Auchensoul; Tramitchel.

[1] It has recently been pointed out by Raymond ('Amer. Journ. Sci.' [4], vol. xix, 1905, p. 377) that the generic name *Amphion* was applied by Hübner in 1816 to a genus of Lepidoptera, while Pander did not propose the name for a trilobite (*A. frontiloba* = *A. fischeri*, Eichw.) till 1830. Angelin's name *Pliomera* (1854) for *A. fischeri*, Eichw., and others of this type, must therefore be adopted in place of the pre-occupied name *Amphion*, Pander.

[2] Brögger, 'Die Silur. Etag. 2 und 3,' p. 135, pl. vi, fig. 3 *a*; Schmidt, 'Rev. Ostbalt. Silur. Trilob.,' pt. i, p. 191, pl. xiii, fig. 8 *a*.

[3] Salter, 'Mon. Brit. Trilob.,' p. 80, pl. vi, fig. 29.

Family Phacopidæ.

Genus **PHACOPS**, Emmrich.

1. **Phacops (Pterygometopus) brongniarti,** Portlock, 1843. Plate XIX, figs. 17, 18.

1843. *Phacops brongniarti,* Portlock, Geol. Rep. Londond., p. 282, pl. ii, fig. 8.
— *Phacops murchisoni,* Portlock, ibid, pl. ii, fig. 9.
— *Phacops dalmani,* Portlock, ibid, pl. ii, fig. 7.
1853. *Phacops brongniarti,* Salter, Mem. Geol. Surv., dec. vii, art. 1, p. 10.
1864 *Phacops* (*Acaste*) *brongniarti,* Salter, Mon. Brit. Trilob , p. 34, pl. i, figs. 20—24 (♂); pl. i, figs. 25, 26 (♀ = *Ph. dalmani*).
1875. *Phacops brongniarti,* Baily, Char. Brit. Foss., p. 41, pl. xiii, figs. 11, *a, b, c,*
1876. *Phacops brongniarti,* Armstrong and Young, Cat. West. Scot. Foss., p. 16.
— *Phacops dalmannii,* Armstrong and Young, ibid., p. 16.
1877. *Phacops* (*Acaste*) *brongniarti,* Woodward, Cat. Brit. Foss. Crust., p. 50.
1878. *Phacops* (*Acaste*) *brongniarti,* Nicholson and Etheridge (*e. p.*), Mon. Silur. Foss. Girvan, fasc. i, p. 99, pl. vii, fig. 1 (*non* fig. 2).
1879. *Phacops* (*Acaste*) *brongniarti,* Nicholson and Etheridge, ibid., fasc. ii, p. 201, pl. xiv, figs. 7, 8.
1899. *Phacops brongniarti,* Reed, Quart. Journ. Geol. Soc., vol. lv, p. 749.
— *Phacops brongniarti,* Mem. Geol. Surv., Silur. Rocks Brit., vol. i, Scotland, pp. 490, 500, 505, etc.
1905. *Phacops* (*Pterygometopus*) *brongniarti,* Reed, Geol. Mag. [5], vol. ii, p. 227.

Remarks.—This well-marked species is especially characteristic of the Balclatchie Group, but seems to occur also on a lower and on a higher horizon. Its characters have been too often described to need repetition here. It has been referred by me (*loc. cit.*, 1905) to the genus or subgenus *Pterygometopus.*

Collections.—Mrs. Gray; Edinburgh Museum (f. M., pl. xiv, fig. 7); Museum of Practical Geology (f. M., pl. vii, fig. 1); Woodwardian [Sedgwick] Museum.

Horizons and Localities.—? Stinchar Limestone Group (Llandeilo): Minuntion. Balclatchie Group (Llandeilo): Ardmillan Brae; Dow Hill; Balclatchie. ? Drummuck Group (U. Bala): Drummuck; ? Starfish Bed, Thraive Glen.

2. **Phacops (Phacopidella) elegans** (Sars & Boeck), 1838. Plate XIX, figs. 19—23.

? 1833. *Trilobites elliptifrons,* Esmark, Mag. f. Naturvid., ser. 2, vol. i, p. 269, pl. vii, figs. 6, 7.
1838. *Trilobites elegans,* Sars and Boeck in Keilhaus' Gæa Norvegica, p. 139.
1851. *Phacops stokesi,* Salter, Quart. Journ. Geol. Soc., vol. vii, p. 171, pl. ix, figs. 2 *a*, 2 *b*.
1852. *Phacops quadrilineata,* Angelin, Pal. Scand., p. 12, pl. ix, fig. 5.
1857. *Phacops stokesi,* Nieszkowski, Archiv Naturk. Liv.-, Est.-, Kurl., ser. i, vol. i, p. 530.

1858. *Phacops stokesi*, Schmidt, Archiv Naturk. Liv.-, Est.-, Kurl., ser. i, vol. ii, p. 184
1860. *Phacops latifrons*, Eichwald (*e. p.*), Leth. ross., p. 1428.
1864. *Phacops stokesi*, Salter (*e. p.*), Mon. Brit. Trilob., p. 21.
1865. *Phacops elegans*, Kjerulf, Veiviser, pp. 20, 21, fig. 31 *b*.
1873. *Phacops stokesi*, Salter (*e. p.*), Cat. Camb. Silur. Foss. Woodw. Mus., p. 76.
1876. *Phacops stokesi*, Armstrong and Young, Cat. West. Scot. Foss., p. 16.
1877. *Phacops stokesi*, Woodward (*e. p.*), Cat. Brit. Foss. Crust., p. 56.
1878. *Phacops stokesi*, Nicholson and Etheridge, Mon. Silur. Foss. Girvan, fasc. i, p. 98.
— *Phacops brongniarti*, Nicholson and Etheridge (*e. p.*), ibid., pl. vii, fig. 2 (*non* fig. 1).
1881. *Phacops elegans*. Marr, Proc. Yorks. Geol. Polyt. Soc., vol. vii, p. 397.
— *Phacops elegans*, Schmidt, Rev. Ostbalt. Silur. Trilob., pt. i, p. 72, pl. i, fig. 1; pl. x, figs. 10—12; pl. xi, fig. 17.
? 1884. *Phacops elliptifrons*, Törnquist, Undersökn. Siljans. Trilobitf., p. 8, pl. i, figs. 1—3 (Sver. Geol. Undersökn., Ser. C, no. 66).
1887. *Phacops elegans*, Marr, Geol. Mag. [3], vol. iv, p. 35.
1888. *Phacops stokesi*, Wigand, Zeitschr. deutsch. Geol. Gesell., vol. xl, p. 40, pl. vi, fig. 1.
1888. *Phacops elegans*, Marr and Nicholson, Quart. Journ. Geol. Soc., vol. xliv, p. 720, pl. xvi, figs. 1—4.
1899. *Phacops stokesi*, Mem. Geol. Surv., Silur. Rocks Brit., vol. i, Scotland, pp. 529, 532, 536, etc.

Remarks.—The specimens from Girvan which are usually attributed to *P. stokesi*, M. Edwards, are referable, so far as I have seen, to the closely allied species *P. elegans*. Wigand and others have, indeed, considered the latter specifically inseparable from *P. stokesi*; but Schmidt has pointed out the manner in which it differs, and Marr and Nicholson (*loc. cit.*) have figured British specimens from the Stockdale Shales. In *P. stokesi* the glabella expands more rapidly towards the front, and the eyes are relatively larger. The glabellar furrows appear to be similar in the two species, and there is no obvious difference in the thorax and pygidium. The Girvan examples have 7—8 segments on the axis of the pygidium, and four pairs of pleuræ on the lateral lobes, but the fourth pair is generally very faint; the pleuræ are furrowed towards their extremities. The axis is usually about three quarters the length of the pygidium. In a specimen from Newlands in Mrs. Gray's collection which perhaps is referable to this species, there are five pairs of pleuræ on the lateral lobes of the pygidium.

The species belongs to the subgeneric group *Phacopidella*, which partly corresponds with the imperfectly defined subgenus for which the pre-occupied name *Acaste* is generally employed.[1]

Collections.—Mrs. Gray (f. M.); Museum of Practical Geology; Edinburgh Museum; Woodwardian [Sedgwick] Museum.

Horizons and Localities.—Mulloch Hill Group (L. Llandovery): Mulloch Hill; Craigens. Saugh Hill Group (M. Llandovery): Newlands; Woodland Point. Camregan Group (U. Llandovery): Bargany Pond Burn; Penwhapple Glen. Penkill Group (Tarannon): Penkill.

[1] Reed, 'Geol. Mag.' [5], vol. ii, 1905, p. 225.

3. **Phacops (Phacopidella) downingiæ** (Murchison), 1839.

1822. *Calymene macrophthalma*, Brongniart, Hist. Nat. Crust. Foss., pl. i, fig. 4 (*non* fig. 5)
1836. *Calymene macrophthalma*, Buckland, Geol. and Min., pl. lxiv, fig. 5 (*non* fig. 4).
1839. *Calymene downingiæ*, Murchison, Silur. Syst., p. 655, pl. xiv, fig. 3.
1839. *Asaphus subcaudatus* and *A. cawdori*, Murchison, ibid., p. 655, pl. vii, figs. 9, 10.
1840. *Calymene downingiæ*, Milne Edwards, Crust., vol. iii, p. 324.
1843. *Acaste downingiæ*, Goldfuss, Neues Jahrb., p. 563.
1843. *Phacops macrophthalma*, Burmeister, Organ. Trilob, pp. 139, 140.
1845. *Phacops downingiæ*, Emmrich, Neues Jahrb., p. 40, pl. i, fig. 2 (translated in Taylor's Scientific Memoirs, 1846, vol iv, pl. iv, fig. 2).
1848. *Phacops downingiæ*, Salter, Mem. Geol. Surv., vol. ii, pt. i, p. 336, pl. v, figs. 2—4.
1851. *Phacops downingiæ*, M'Coy, Synops. Pal. Foss. Woodw. Mus., p. 160.
1853. *Phacops downingiæ*, Salter, Mem. Geol. Surv., dec. vii, pl. i.
1854. *Phacops downingiæ*, Morris, Cat. Brit. Foss., 2nd ed., p. 113.
? 1854. *Phacops breviceps*, Angelin, Pal. Scand., p. 12, pl. ix, fig. 4 *a*.
1857. *Phacops downingiæ*, Nieszkowski, Archiv Naturk. Liv.-, Est.-, Kurl., ser. 1, vol. i, p. 531.
1859. *Phacops downingiæ*, Murchison, Siluria, 2nd ed., pl. xviii, figs. 2—5.
1864. *Phacops* (*Acaste*) *downingiæ*, Salter, Mon. Brit. Trilob., p. 24, pl. ii, figs. 17—36.
1873. *Phacops downingiæ*, Salter, Cat. Camb. Silur. Foss. Woodw. Mus., p. 131.
? 1874. *Phacops dubius*, Steinhardt, Die preuss. Geschieb. gef. Trilob., p. 14, pl. i, fig. 7.
1875. *Phacops downingiæ*, Baily, Char. Brit. Foss., p. 68, pl. xxiii, fig. 6.
? 1876. *Phacops downingiæ*, Armstrong and Young, Cat. West. Scot. Foss., p. 16.
1876. *Phacops downingiæ*, Schmidt, Verh. Min. Gesell. S. Petersb., n. s. vol. x, p. 15, pl. i, fig. 1.
1877. *Phacops* (*Acaste*) *downingiæ*, Woodward, Cat. Brit. Foss. Crust., p. 51.
1878. *Phacops downingiæ*, Nicholson and Etheridge, Mon. Silur. Foss. Girvan, fasc. i, p. 98.
1881. *Phacops downingiæ*, Schmidt, Rev. Ostbalt. Silur. Trilob., pt. i, p. 75, pl. i, fig. 2; pl. xi, fig. 18.
1885. *Phacops downingiæ*, Lindström, Förteckn. Gotl. Silur. Crust. (Ofv. K. Svensk. Vet. Akad. Förhandl., no. 6), p. 42.
1888. *Phacops downingiæ*, Wigand, Zeitschr. deutsch. Geol. Gesell., vol. xl, p. 41, pl. vi, figs. 2, 3.
1890. *Phacops* (*Acaste*) *downingiæ*, Pompecki, Die Trilobit. f. Ost. West-preuss. Diluv. Geschieb., p. 19, pl. i, figs. 27, *a—c*.
1899. *Phacops downingiæ* (*e. p.*), Mem. Geol. Surv., Silur. Rocks Brit., vol. i, Scotland, pp. 529, 530, 689.

Remarks.—It must still remain doubtful whether the true *P. downingiæ* occurs in the Girvan area. I have seen poor specimens from Woodland Point which may possibly be referable to it; but, as Nicholson and Etheridge remarked (M, fasc. i, 1878, p. 98), the specimens usually attributed to it belong to *P. stokesi* (= *P. elegans*). The species is included by me in the subgenus *Phacopidella*.[1]

Collections.—Mrs. Gray; Museum of Practical Geology.

Horizons and Localities.—Saugh Hill Group (M. Llandovery): Woodland Point. ? Wenlock Series: Knockgardner, Straiton.

[1] The opinion expressed by Drevermann ('Neues Jahrb. f. Miner.,' 1906, vol. ii, Ref. p. 139) that this subgeneric name is superfluous, seems based on a strange misapprehension of its phylogenetic significance.

4. **Phacops (Chasmops) bisseti,** sp. nov. Plate XX, figs. 1—3.

Specific Characters.—Head-shield transversely semicircular, more than twice as broad as long, gently convex. Glabella scarcely raised above cheeks, triangular in shape, twice as wide at front end as at base; length considerably less than width at front end. Frontal lobe large, rather flattened in front, transverse, short, more than two and a half times as wide as long; lateral angles overhanging "cat's ear" lobes, and projecting laterally to facial sutures, and nearly overhanging the eyes; V-shaped mark, composed of coarse puncta, on frontal lobe. The "cat's ear" lobes extend rather more than half along the sides of the glabella, and their inner angle, where they unite with the central portion of the glabella, is about 70° and is marked by a rather prominent tubercle, while the posterior lateral angle made with the axial furrow is nearly 90°. First lateral furrows slightly undulating, and making between them angle of 120°—130°; not meeting the shorter second lateral furrows. Central portion of glabella between inner angles of "cat's ear" lobes less than one third total width of glabella. "Second"[1] lateral lobes represented by small prominent nodules near inner ends of second lateral furrows. "Third" lateral lobes represented by faint swellings on a transverse rounded band behind the "cat's ear" lobes. Neck-ring rounded, marked off by strong occipital furrow from this transverse band, and about half as wide again as the latter. Axial furrows strong, diverging anteriorly from neck-ring at about 75°—80° as far as the first lateral furrows, in front of which they bend outwards round the overhanging angles of the frontal lobe. Surface of glabella finely granulated with numerous large coarse tubercles, scattered freely over it. Cheeks triangular, nearly as high as glabella, with the usual characters found in *Chasmops*. Lateral margins of head-shield strongly bent down; and free cheeks furnished with long, broad, flattened, genal spines, closely pressed against body, and extending back to at least the eighth thoracic segment. Surface of cheeks granulated and rather coarsely pitted. Eye of moderate size, strongly curved, high, conical, with its base at the level of the second lateral furrow, and its front end about two thirds of the way up the "cat's ear" lobes. Eye-lobe very prominent, and bent up along anterior and posterior edges. Visual surface of eye composed of about thirty vertical rows of lenses, with twelve to fourteen lenses in the highest rows.

Thorax of eleven segments, half as long again as head-shield. Axis rather

[1] The author would prefer to call the lateral portions of the frontal lobe the *first* pair of lateral lobes and the "cat's ear" lobes the *second* pair, making the so-called "second" lateral lobes really the *third*. But to avoid confusion the commonly accepted terminology is here employed, though he believes the homology implied is erroneous (see 'Quart. Journ. Geol. Soc.,' vol. lviii, 1902, p. 64).

less than one third the width of thorax at about the sixth ring, behind which it gently tapers to pygidium; gently convex; each ring with low but distinct nodular swelling on axial furrows. Axial furrows strong and deep. Pleuræ curved gently backwards and downwards beyond the weak fulcrum which is situated at about half their length. Strong oblique furrow along each pleura.

Pygidium transversely parabolic, about one and a half times as broad as long. Axis conical, about one third the width of pygidium and reaching nearly its whole length, tapering gradually to a rounded extremity; composed of twelve distinct rings followed by four narrow faint ones. Lateral lobes strongly bent down, especially near margin; bearing one half pleura on front edge followed first by eleven pairs of regular pleuræ (each with very faint, central, impressed line), and then by four pairs of very weak narrow pleuræ and by one median unpaired one which runs nearly straight back behind axis. Posterior margin of pygidium between last four pairs of pleuræ strongly bent up and appearing from behind almost angulated in centre. Surface of thorax and pygidium finely granulated.

Dimensions.—

Length of head-shield	16·0 mm.
Width ,,	37·0 ,,
,, of glabella at base	9·0 ,,
,, ,, in front	23·0 ,,
Length ,,	13·5 ,,
,, of frontal lobe of glabella	8·5 ,,
,, of eye	5·0 ,,
,, of thorax	25·0 ,,
Width ,,	35·0 ,,
,, of axis of thorax	11·0 ,,
Length of pygidium	18·0 ,,
Width ,,	25·0 ,,
Length of axis of pygidium	15·0 ,,
Width ,,	9·0 ,,

Remarks and Affinities.—The above description is drawn up from a remarkably perfect specimen of a complete individual which has been most kindly lent me for examination by Mr. James Bisset, F.G.S., of Edinburgh. The specimen came from the Drummuck Beds of Lady Burn, and (with the exception of one head-shield recently discovered by Mrs. Gray) is the sole representative of the subgenus *Chasmops* which I have seen from Girvan. It measures nearly 60 mm. in total length, and appears to belong to a new species.

This specimen cannot be referred to *P. macroura*, Sjögr., as interpreted by Salter,[1] because of (1) its differently shaped glabella with its greater anterior expansion; and (2) its shorter and more transverse pygidium with fewer segments.

[1] Salter, 'Mon. Brit. Trilob.,' p. 37, pl. iv, figs. 18—23.

In *P. macroura*, Sjögr., Angelin[1] describes eighteen ribs to the pygidium, and in the English form Salter states there are sixteen. The glabella, moreover, is much more nearly square in *P. macroura*, and the frontal lobe is longer and less transversely expanded. Schmidt[2] considers it probable that Salter's *P. macroura* really belongs to *P. eichwaldi*, Schmidt, but the latter is described as having only 12—15 segments in the pygidium, which is also pointed and a little broader than long; the surface of the head-shield is, moreover, only finely granulated or quite smooth instead of tuberculated, and the frontal lobe of the glabella measures less in breadth than does the head-shield in length. *P. eichwaldi* therefore seems not only distinct from Salter's *P. macroura* but also from the Girvan form.[3]

The general proportions of the head-shield of *P. conicophthalmus* (Boeck), and the size and shape of the glabellar lobes with the overhanging lateral angles of the frontal lobe, closely resemble the Girvan specimen, but the genal angles are only furnished with short spines, and the eyes are smaller. The pygidium attributed to this species by Salter (*op. cit.*, pl. vi, fig. 25) is completely different.

The species *P. wesenbergensis*, Schmidt,[4] from Stage E, has many points of similarity to the Girvan form, especially in the glabella and its lobes, and in their proportions. But the "cat's ear" lobes are rather smaller, the first lateral furrows are rather more oblique, the eye has only twenty-four rows of lenses with 10—11 lenses in the middle row, the genal spines are not vertical, the pygidium is relatively rather longer, and the axis appears to taper less rapidly.

The form described by the author as *P. marri*[5] from the Coniston Limestone may also be compared, but the shape and proportions of the glabella and lobes are different.

The head-shield in Mrs. Gray's collection has lost the free cheeks, and belongs to a smaller and probably younger individual, which may account for the slight differences noticeable in it when compared with Mr. Bisset's specimen. The glabella has a less transverse appearance, the axial furrows diverging only at 70°—75° instead of 75°—80°. The inner angle of the "cat's ear" lobes of the glabella is nearly 90° instead of 70°, while the posterior angle is 70° instead of 90°. In all other respects there is complete agreement. The dimensions are as follows: length of head-shield 11·5 mm.; length of glabella 9·5 mm.; basal width of glabella 5·0 mm.; frontal width of glabella 12·5 mm.

There is a fragment of a pygidium, probably belonging to the same species as Mr. Bisset's specimen, from the Starfish Bed in Mrs. Gray's collection; it shows 15—16 rings on the axis, the last 3 or 4 of which are indistinct, and 11—13 pleuræ on the lateral lobes.

[1] Angelin, 'Pal. Scand.,' p. 9.

[2] Schmidt, 'Rev. Ostbalt. Silur. Trilob.,' pt. i, p. 117.

[3] Reed, 'Geol. Mag.' [5], vol. i (1904), p. 386, pl. xii, fig. 3.

[4] Schmidt, *op. cit.*, p. 115, pl. iv, figs. 10—12; pl. v, figs. 1—7; pl. x, fig. 20.

[5] Reed, 'Geol. Mag.' [4], vol. i (1894), p. 241, pl. vii, figs. 1—3.

On the whole the Girvan specimens appear to be specifically distinct from any hitherto described, and the name *P. bisseti* may be appropriately given to them.

Collections.—Mr. Bisset (Edinburgh); Mrs. Gray.

Horizon and Locality.—Drummuck Group (U. Bala): Lady Burn; Thraive Glen (Starfish Bed).

SUPPLEMENTARY NOTES.

Family TRINUCLEIDÆ.

Genus **TRINUCLEUS,** Llwyd.

Trinucleus, sp. ind. (*b*).

1903. *Trinucleus,* sp. ind. (*b*), Reed, *supra,* p. 14, pl. ii, figs. 8, 8 *a*.

Within a space measuring 40 × 50 mm. on one slab of rock from Whitehouse Bay, there are three well-preserved head-shields of the trilobite described as *Trinucleus* sp. ind. (*b*). The fringe is poorly exposed and shows only one concentric row of large pits in front, probably due to the radial fusion of the pits of the two rows previously described, since 2—3 rows are present at the genal angles. In the former description it was stated that the surface of the glabella is smooth, but this is not the case with these new specimens, which have the shell perfectly preserved, for a fine reticulation, which gives the appearance of a honeycombed, pitted surface, ornaments the swollen ovoid portion of the glabella. An isolated small, round, submedian tubercle is also present on this part. The neck of the glabella and the cheeks are, however, quite smooth and devoid of any reticulation or tubercles; no ocular tubercles can be detected. The peculiar lobeless, subcylindrical neck is somewhat contracted at its base, and is only about one fourth the length of the whole glabella. The glabella does not overhang the fringe at all in front, but ends well inside it, sloping down to it rather more gradually than to the neck, the apex of the ovoid lobe being post-median. The dimensions of the three head-shields are as follows:

	I.	II.	III.
Length .	10·5 .	11·5 .	7·75 mm.
Width .	19·5 .	20·0 .	12·00 ,,

Collection.—Mrs. Gray.

Horizon and Locality.—Whitehouse Group (M. Bala): Whitehouse Bay.

Genus **AMPYX**, Dalman.

Ampyx incurvus, sp. nov. Plate XX, figs. 6—8.

1903. *Ampyx mammillatus*, Sars (?), Reed, *supra*, p. 22, pl. iii, fig. 13.

Some better preserved specimens of the species referred to *Ampyx mammillatus* (Sars) ? from the Balclatchie Group occur amongst the new material which Mrs. Gray has collected from Dow Hill and Ardmillan. From these head-shields it is found that the glabella is strongly elevated in front above the cheeks, sloping up to the frontal spine gradually from the neck, but very abruptly from the anterior margin of the shield, beyond which it slightly projects. The pairs of lateral pits and oblique furrows on each side of the glabella generally unite, so as to enclose one pair of longitudinally oval areas, as in *A. hastatus*, Ruedemann.[1] The carination of the glabella is more marked than was indicated in fig. 13, Pl. III. The spine which is situated at the pointed anterior end and highest part of the glabella is not directed straight forwards, but curves gently upwards and then backwards, attaining a length equal to more than twice that of the glabella. The lateral furrows or pits on the glabella are usually more strongly marked than indicated in the specimen previously figured.

The curvature of the peculiar rostral spine, as well as the shape of the glabella and its oval lateral impressions, recalls *A.* (*Lonchodomas*) *hastatus*, Ruedemann, from the Trenton Conglomerate of Rysedorph Hill, N. Y., but the carination in the latter is more marked and the lateral furrows on it are dissimilar, while the rostral spine in our form is rounded and not prismatic. The specific name *incurvus* is suggested, as it is undoubtedly distinct from *A. mammillatus* and other allied species.

In one specimen there are six thoracic segments attached to the head-shield in position. The axis is subcylindrical, tapering very slightly towards the pygidium, and it is four fifths the width of the pleural portions on each side. Each axial ring is furnished with a pair of strong, well-defined, rounded lateral nodes. The horizontally extended pleuræ possess the usual characters of the genus, but the furrow is distinctly diagonal near the axis and widens outwards towards the extremity of the pleura.

[1] Ruedemann, 'Bull. 49, New York State Mus.' (1901), p. 48, pl. iii, figs. 1—10, 30.

Family OLENIDÆ.

Genus **REMOPLEURIDES,** Portlock.

Remopleurides (Teratorhynchus) bicornis, Reed.

1903. *Remopleurides (Teratorhynchus) bicornis,* Reed, *supra*, p. 33, pl. v, figs. 5—16.

The upper and major recurved spine in this species was not described as laterally grooved in the previous diagnosis of its characters. A good cast of the anterior portion of a head-shield from the typical locality, Dow Hill, is now available, which shows a lateral longitudinal median narrow groove running along each side of the spine from its base to nearly its tip.

Family ASAPHIDÆ.

Genus **ASAPHUS,** Brongniart.

Asaphus (Isotelus) instabilis, Reed. Plate XX, fig. 4.

1903. *Asaphus (Isotelus) instabilis,* Reed, *supra*, p. 46, pl. vii, figs. 2—8.

There is an excellent detached free cheek of *A. instabilis* from Dow Hill in the new material which Mrs. Gray has collected, and it shows the characteristic features better than the one figured previously (Pl. VII, fig. 6). The angle between the two branches of the facial suture, the distance of the eye from the posterior margin of the head-shield, the distance of the point of section of the margin by the posterior branch of the facial suture from the genal angle, the almost rectangular inclination of the lateral and posterior margins of the free cheek to each other at the genal angle, the shallow lateral marginal furrow, the absence of a broad neck-furrow, and the sharp, abruptly originating spine at the genal angle, are features which are well exhibited in the specimen before us.

Genus **CYCLOPYGE,** Corda.

Cyclopyge rediviva (Barrande)?.

1904. *Cyclopyge rediviva,* Reed, *supra*, p. 52, pl. viii, figs. 2, 3.

There are some isolated and imperfect thoracic rings of a species of *Cyclopyge* from Whitehouse Bay which have been recently found by Mrs. Gray. They

possess a broad axis bearing on each ring a pair of circular gland-like pits resembling those found on the third ring of *C. binodosa*, Salter.[1] The pleuræ are short and imperfect. Probably these segments belong to *C. rediviva*, as they agree in point of size.

Cyclopyge cf. **gigantea** (Barrande). Plate XX, fig. 5.

One pygidium from Whitehouse Bay amongst Mrs. Gray's recently collected material belongs undoubtedly to the genus *Cyclopyge*, but does not seem to be referable either to *C. armata* or *C. rediviva*. It has a transversely semicircular shape, and a well-marked, raised, rounded border; the axis is conical, pointed, and well defined by the axial furrows, which extend with nearly uniform strength to its tip, and converge at an angle of about 45°; the axis is completely ringed to its tip by five or six annulations, of which the first three are strongly marked; the lateral lobes are very slightly convex and show faint traces of 3—4 pleuræ, but these are very indistinct. The first lateral furrow is, however, strong.

The pygidium figured by Barrande as belonging to a young individual of *C. gigantea* (Barr.)[2] has a somewhat similar long pointed conical axis, with traces of several rings upon it and of faint pleuræ on the lateral lobes. In *C. prisca* (Barr.)[3] the axis is too short and blunt, but has 3—4 rings well marked on it.

Dimensions.—

Length of pygidium	7·0 mm.
„ of axis	5·0 „
Width of pygidium . . .	*ca.* 14·0 „
„ of axis at front end . . .	4·25 „

Genus **ILLÆNUS,** Dalman.

Illænus balclatchiensis, Reed ?. Plate XX, fig. 11.

1904. *Illænus balclatchiensis*, Reed, *supra*, p. 56, pl. viii, figs. 12—16.

There is now available one good hypostome from Balclatchie which may be probably attributed to the species *I. balclatchiensis*. It is transverse in shape, being nearly twice as wide as long. The anterior edge is nearly straight; the lateral wings form very broad, flattened, rounded lobes, slightly upturned behind;

[1] Salter, 'Mem. Geol. Surv.,' dec. xi, no. iv (1864), pl. iv, figs. 1—6.

[2] Barrande, 'Syst. Silur. Bohême,' suppl. vol. i, p. 60, pl. i, fig. 5.

[3] Ibid., p. 63, pl. v, fig. 2.

the body, which is weakly convex and not marked off from them anteriorly, is subcircular in shape, narrowing slightly behind, and the lateral wings extend along half its length; behind them is a border of moderate width, marked off on each side from the body by a strong, slightly oblique furrow; these furrows do not meet behind, and apparently are composed of the marginal and lateral furrows, as they bend inwards more strongly at their posterior ends; behind them the body is not marked off from the border. The whole surface of the hypostome is ornamented with fine, wavy lines concentric to the posterior and lateral margins and meeting the anterior margin at a more or less acute angle. The type of hypostome is that of *I. chiron*, Holm, *I. esmarki*, Schloth., etc.[1]

Dimensions.—

Length	7 mm.
Width at front end	12 ,,

Illænus bowmani, Salter. Plate XX, fig. 10.

1904. *Illænus bowmani*, Reed, *supra*, p. 59.

There is an interesting specimen of *I. bowmani* from the Starfish Bed which shows the whole individual both as a cast and a hollow mould, though neither is quite perfect. But the most important feature is the preservation of the hypostome in its natural attachment to the epistome, though it does not lie in the normal plane, having been bent back underneath the latter. The epistome is broken laterally, but appears to have had the usual transverse fusiform shape without any marked posterior protuberance, and it is crossed by 12—14 strong, equidistant, scarcely curved, striæ. The hypostome is subquadrate in shape, wider than long, and arched down on each side. The anterior margin is a flattened curve, but the lateral angles are rounded, the anterior wings being placed far back and nearly opposite the middle of the body. The body itself is subquadrate and moderately convex, and has a pair of rather large lateral pits a little behind its middle, and there is a faint shallow depression connecting them and curving round behind the body so as to mark off indistinctly a posterior border. The posterior end of the hypostome is broad and obtuse.

A few fine, irregular, raised lines are visible on the alæ, but the ornamentation is not preserved on the rest of the surface.

Dimensions.—

Length of hypostome		. . .	11·0 mm.
Width	,,	across anterior alæ .	19·0 ,,
,,	,,	behind alæ . .	10·0 ,,

[1] Lindström, 'K. Svensk. Vet. Akad. Handl.,' vol. xxxiv, no. 8 (1901), p. 58, pl. iv, figs. 22—38

Illænus extensus, Reed.

1904. *Illænus extensus*, Reed, *supra*, p. 61, pl. ix, figs. 3—5.

In the type specimen of *I. extensus* the anterior margin of the head-shield was broken and imperfect, and its true proportions and shape could not be accurately determined, but it appeared to be transversely semicircular. A small but complete individual is now available from the same horizon and locality (Starfish Bed, Thraive Glen); and though its surface is not so well preserved, the outline of the head is well exhibited, and it is seen to be parabolic and not semicircular, being somewhat pointed in front. The dimensions of this young individual, which, though so small, possesses the typical nine thoracic segments and all the other characteristic features of the species, are as follows:

Length of head-shield . . .	5·00 mm.
Width ,, . . .	10·50 ,,
Length of thorax	3·00 ,,
,, pygidium. . . .	3·75 ,,
Width ,, ...	7·50 ,,

Illænus macallumi, Salter.

1904. *Illænus macallumi*, Reed, *supra*, p. 65.

This species has now to be recorded from another locality in the Girvan district, as in Mrs. Gray's new material there is a pygidium from Craigens (Mulloch Hill Group, Lower Llandovery).

Illænus memorabilis, sp. nov. Plate XX, fig. 9.

1904. *Illænus* cf. *oculosus*, Reed (*pars*), *supra*, p. 71, pl. x, fig. 11 (*non* figs. 9, 10).

Specific Characters.—The head-shield is only slightly convex from side to side and from back to front, and is not bent down anteriorly. The middle shield is subquadrate in form, the long anterior branches of the facial suture being subparallel, and the width of the head between them only slightly greater than the length. The eyes are rather large, and placed so far back as nearly to touch the posterior margin; the eye-lobes are semicircular and project laterally, and the surface of the cheek between them and the axial furrows is decidedly swollen. The axial furrows present the most remarkable feature in the head-shield on account of their length and course; they converge at first rather strongly in their

forward course for about one third the length of the head-shield, and then diverge from each other strongly, curving outwards and being continued forwards to within a short distance of the anterior margin to end in small pits. In front of these pits the head-shield is marked with strong regular rugæ and striæ (terrace-lines), concentric to the anterior margin. The axial furrows are of equal strength along their whole course, and are well marked; but just behind their nearest approach in their posterior course there is an oval expansion of the furrows, forming a pair of special depressed areas a little in front of the eyes. Owing to the course of the axial furrows, the glabella has an hour-glass shape, its waist being only just half the width of its anterior end, while its base is about a third wider than its waist. The glabella has no independent convexity except behind its waist, where it is gently convex, and it is not defined at its anterior end. There is a small median tubercle close to the base of the glabella. The neck furrow is narrow and indistinct.

Dimensions.—

Length of head-shield . . .	14·50 mm.
Width ,, between eyes . .	19·50 ,,
Length of glabella	11·25 ,,
Width ,, at base . . .	9·00 ,,
,, ,, waist . . .	5·75 ,,
,, ,, front end. . .	12·00 ,,

Remarks.—The above described nearly complete head-shield (without the free cheeks) from Dow Hill, shows some noticeable peculiarities which mark it off as a distinct species. The posterior portion of a head-shield of the same species from Ardmillan was previously described by the author (*op. cit. supra*) as comparable with *I. oculosus*, Holm, but it must now be removed from this association, as it is certainly distinct from the other specimens referred to under that title. The species which has been described from the Trenton and Chazy Limestones as *I. indeterminatus*, Walcott,[1] much resembles our species in the peculiar course of the axial furrows and long glabella, but it differs in the greater distance of the eyes from the posterior margin. *I. ladogensis*, Holm,[2] from the Ordovician (B 3) of the Baltic provinces, agrees likewise in the general development of the axial furrows, but the eyes are smaller and more forward in position, and the glabella is strongly swollen and rises much higher than the cheeks. The inflation of the fixed cheeks between the glabella and the eye-lobe and the position of the latter recall *I. chudleighensis*, Holm,[3] but in other respects the head-shield is quite different.

[1] Raymond, 'Ann. Carnegie Museum,' vol. iii, no. 2 (1905), p. 347, pl. 13, figs. 1, 2.

[2] Holm, 'Rev. Ostbalt. Silur. Trilob.' ('Mém. Acad. Imp. Sci. St. Pétersb.,' vol. xxxiii, no. 8, 1886), p. 113, pl. iii, figs. 5 *a*—*e*.

[3] Ibid., p. 101, pl. iii, figs. 1, 3, 4.

Family Proetidæ.

Genus **CYPHASPIS,** Burmeister.

Cyphaspis megalops (M'Coy).

1904. *Cyphaspis megalops*, Reed, *supra*, p. 82.

The only specimen of this species from the Girvan area which had previously come under my notice was the one in the Sedgwick Museum from the Mulloch Hill Group of Mulloch Quarry as mentioned on p. 82. But in the recent material collected by Mrs. Gray a nearly complete individual showing the head, thorax, and pygidium has been recognised from the Starfish Bed (Drummuck Group), Thraive Glen, which is a new horizon and locality for this species in the Girvan area. Only the free cheeks in this specimen are missing, and it exhibits all the typical characters. It has been found in the Sholeshook Limestone and Slade Beds of the Haverfordwest district.[1]

Genus **MENOCEPHALUS,** Owen.

Menocephalus? (Törnquistia) cf. **nicholsoni,** Reed.

1904. *Menocephalus* (*Törnquistia*) cf. *nicholsoni*, Reed, *supra*, p. 86, pl. xii, figs. 3—7.

This species has only been previously identified from the Balclatchie Beds, but I have detected one indubitable (though somewhat flattened) head-shield showing the usual characters in the Middle Bala of Whitehouse Bay. The true generic position and affinities of this species are as obscure as ever.

Family Lichadidæ.

Genus **LICHAS,** Dalman.

Lichas (Platylichas) grayi, Fletcher, var. ind. Plate XX, fig. 12.

One well-preserved head-shield without the free cheeks deserves notice, as it differs from typical examples of *L. grayi*, var. *scoticus* (*supra*, p. 100), by possessing

[1] Reed, 'Geol. Mag.' [5], vol. ii (1905), p. 98.

a longer and narrower central lobe to the glabella and more elongate bicomposite lobes. There is also a faint trace of the posterior part of the axial furrows as in *L. bulbiceps*, and the occipital lobes are subquadrate as in that species. The whole head-shield measures 12·25 mm. in length, of which the glabella occupies 10·5 mm.; the width of the latter at its anterior end is 8·75 mm., and at its base 9 mm. between the posterior ends of the axial furrows on the outside of the occipital lobes. The bicomposite lobes, which do not converge strongly posteriorly, measure 5·75 mm. long by 3 mm. wide. The width of the base of the central lobe between the inner angles of the occipital lobes is 4·5 mm.

We can hardly separate this form from *L. grayi* or its variety *scoticus*, but it offers certain interesting deviations from the typical proportions of the Wenlock examples of the former, and they point in an opposite direction to those exhibited in the variety *scoticus*.

Collection.—Mrs. Gray.

Horizon and Locality.—Mulloch Hill Group (L. Llandovery) : Mulloch Hill.

LIST OF SPECIES.

Family Agnostidæ.

Agnostus agnostiformis (M'Coy).
,, *girvanensis*, sp. nov.
,, *perrugatus*, Barr.
,, *tardus*, Barr.

Family Harpedidæ.

Harpes flanagani, Portl. ?
,, sp. ind. (*a*) to (*c*).

Family Trinucleidæ.

Trinucleus bucklandi, Barr.
,, ? *macconochiei*, Eth. and Nich.
,, *subradiatus*, sp. nov.
,, sp. ind. (*a*) to (*g*).
Ampyx depressus (Ang.) ?
,, *drummuckensis*, sp. nov.
,, *hornei*, Eth. and Nich.
,, *incurvus*, sp. nov.
,, *macallumi*, Salt.
,, *mammillatus*, var. *austini*, Portl. ?
,, cf. *foveolatus*, Ang.
,, cf. *scanicus* (Ang.)
Dionide lapworthi, Eth. and Nich.
,, *richardsoni*, sp. nov.

Family Olenidæ.

Triarthrus becki, Green ?
Apatokephalus, sp.
Remopleurides barrandei, Eth. and Nich.
,, (*Teratorhynchus*) *bicornis*, sp. nov.
,, *colbii*, Portl. ?
,, *correctus*, sp. nov.
,, *dorsospinifer*, Portl.
,, *longicostatus*, Portl.
,, *salteri*, Reed, var. nov., *girvanensis*.
,, cf. *nanus* (Herz. v. Leucht.)
,, cf. *platyceps*, M'Coy.
Shumardia scotica, sp. nov.
Salteria primæva, Wyv. Thom.
Telephus fractus, Barr.

Family Asaphidæ.

Asaphus (*Isotelus*) *gigas*, De Kay ?
,, ,, *instabilis*, sp. nov.
,, sp. ind.
Stygina latifrons (Portl.)
Cyclopyge armata (Barr.).
,, *rediviva* (Barr.).

Family Asaphidæ—*continued.*

Cyclopyge, cf. *gigantea* (Barr.).
Bohemilla, sp.
Illænus aemulus, Salt.
„ „ var.
„ *balclatchiensis*, sp. nov.
„ *barriensis* (Murch.).
„ *bowmani*, Salt. ?
„ „ var. *longicapitatus*, Reed.
„ *davisi*, Salt. ?
„ *extensus*, sp. nov.
„ *latus*, M'Coy.
„ *macallumi*, Salt.
„ *memorabilis*, sp. nov.
„ *murchisoni*, Salt. ?
„ *nexilis*, Salt.
„ *portlocki*, Salt.
„ *shallochensis*, sp. nov.
„ *thomsoni*, Salt.
„ cf. *oculosus*, Holm.
„ cf. *perovalis*, Murch.
„ sp. ind. (*a*).

Family Proetidæ.

Proetus girvanensis, Eth. and Nich.
„ *latifrons* (M'Coy).
„ *procerus*, Eth. and Nich.
„ *pseudolatifrons*, sp. nov.
„ *stokesi* (Murch.).
„ cf. *obconicus*, Lindstr.
„ sp. ind.
Cyphaspis megalops (M'Coy).
Arethusina konincki, Barr. ?
Phillipsinella parabola (Barr.).
Menocephalus ? (*Törnquistia*) cf. *nicholsoni*, Reed.

Family Bronteidæ.

Bronteus andersoni, Eth. and Nich.
„ *craigensis*, sp. nov.
„ *grayi*, sp. nov.
„ sp. ind. (*a*) and (*b*).
Bronteopsis ardmillanensis, sp. nov.
„ *scotica*, Salt.

Family Lichadidæ.

Lichas (*Corydocephalus*) *anglicus* (Beyr.).
„ „ *geikiei*, Eth. and Nich.
„ „ *scutalis*, Salt.

Family Lichadidæ—*continued.*

Lichas (*Corydocephalus*) cf. *wesenbergensis*, Schm.
„ (*Platylichas*) *grayi*, Fletch., var. nov., *scoticus*.
„ „ var. ind.
„ „ *laxatus*, M'Coy.
„ (*Metopolichas*) *bulbiceps*, Phill. var.
„ „ aff. *marginatus*, Lindstr.
„ (*Amphilichas*) *hibernicus* (Portl.).
„ „ sp.
„ (*Conolichas*) cf. *æquiloba*, Steinh.
„ sp. ind. (*a*).
Lichapyge ? *problematica*, sp. nov.

Family Acidaspidæ.

Acidaspis barrandei, Fletch. and Salt.
„ *callipareos*, Wyv. Thom.
„ *coronata*, Salt.
„ *deflexa*, Lake.
„ *grayæ*, Eth. jun.
„ *hystrix*, Wyv. Thom.
„ *lalage*, Wyv. Thom.
„ *dalecarlica*, Törnq. ?

Family Encrinuridæ.

Encrinurus punctatus (Brünn.), var. *calcareus*.
„ „ „ var. *arenaceus*.
„ *multisegmentatus*, Portl.
Cybele cf. *aspera*, Linnars.
„ *bellatula* (Dalm.) ?
„ *loveni*, Linnars., var. nov. *girvanensis*.
„ *verrucosa*, Dalm. ?
„ sp. ind. (*a*) and (*b*).
Dindymene cordai, Eth. and Nich.

Family Calymenidæ.

Calymene blumenbachi, Brongn.
„ „ var. nov. *drummuckensis*.
„ *cambrensis*, Salt.
„ *planimarginata*, sp. nov.
„ sp. ind. (*a*) and (*b*).

Family Cheiruridæ.

Cheirurus bimucronatus (Murch.).
„ *gelasinosus* (Portl.).

Family Cheiruridæ—*continued.*

Cheirurus gelasinosus (Portl.) var. ?

„ (*Cyrtometopus*) *octolobatus* (M'Coy).

„ (*Nieszkowskia*) *unicus* (Wyv. Thom.).

„ (*Sphærocoryphe*) *thomsoni*, sp. nov.

„ (*Youngia*) *trispinosus*, Young.

„ sp. (*a*) and (*b*).

Deiphon forbesi, Barr.

Family Cheiruridæ—*continued.*

Sphærexochus mirus, Beyr.

Staurocephalus globiceps (Portl.).

Pliomera, sp.

Family Phacopidæ.

Phacops (*Pterygometopus*) *brongniarti*, Portl.

„ (*Phacopidella*) *downingiæ* (Murch.) ?

„ „ *elegans* (Sars and Boeck).

„ (*Chasmops*) *bisseti*, sp. nov.

STRATIGRAPHICAL DISTRIBUTION.

ORDOVICIAN.

Stinchar Limestone Group.

Family Harpedidæ. *Harpes flanagani*, Portl. ? ; *Harpes*, sp. ind. (*c*).

Family Trinucleidæ. *Trinucleus*, sp. ind. (*g*.) ; *Ampyx* cf. *foveolatus*, Ang.

Family Olenidæ. *Remopleurides* cf. *nanus*, H. v. Leucht.

Family Asaphidæ. *Asaphus*, sp. ind. ; *Illænus davisi*, Salt. ? ; *I. latus*, M'Coy ; *I. murchisoni*, Salt. ? ; *I. portlocki*, Salt. ; *I.* cf. *perovalis*, Murch. ; *I.*, sp. ind. (*a*).

Family Bronteidæ. *Bronteus craigensis*, sp. nov. ; *B. grayi*, sp. nov. ; *B.*, sp. ind. (*a*) and (*b*) ; *? Bronteopsis scotica*, Salt.

Family Lichadidæ. *Lichas* (*Amphilichas*) *hibernicus*, Portl.

Family Encrinuridæ. *Encrinurus punctatus* (Brünn.), var. *arenaceus*, Salt. ; *? Cybele bellatula*, Dalm. ? ; *C. verrucosa*, Dalm. ?

Family Calymenidæ. *Calymene cambrensis*, Salt.

Family Cheiruridæ. *Cheirurus gelasinosus*, Portl. ; *Sphærexochus mirus*, Beyr. ; *Pliomera*, sp.

Family Phacopidæ. ? *Phacops* (*Pterygometopus*) *brongniarti*, Portl.

Balclatchie Group.

Family Agnostidæ. *Agnostus girvanensis*, sp. nov.

Family Harpedidæ. *Harpes flanagani*, Portl. ?.

Family Trinucleidæ. *Trinucleus ? macconochiei*, Eth. and Nich. ; *T. subradiatus*, sp. nov. ; *Ampyx hornei*, Eth. and Nich. ; *A. macallumi*, Salt ; *A. incurvus*, sp. nov. ; *A. mammillatus*, var. *austini*, Portl.

Family Olenidæ. *Triarthrus becki*, Green ? ; *Apatokephalus*, sp. ; *Remopleurides barrandei*, Eth. and Nich. ; *R.* (*Teratorhynchus*) *bicornis*, sp. nov. ; *R. correctus*, sp. nov. ; *R. dorsospinifer*, Portl. ; *R. longicostatus*, Portl. ; *R. salteri*, Reed, var. nov., *girvanensis* ; *Salteria primæva*, Wyv. Thom.

Family Asaphidæ. *Asaphus* (*Isotelus*) *gigas*, DeKay ? ; *A.* (*I.*) *instabilis*, sp. nov ; *Illænus balclatchiensis*, sp. nov. ; ? *I. latus*, M'Coy ; *I.* cf. *oculosus*, Holm. ; *I. memorabilis*, sp. nov.

Family Proetidæ. *Arethusina konincki*, Barr. ? ; *Menocephalus* (*Törnquistia*) cf. *nicholsoni*, Reed.

Family BRONTEIDÆ. *Bronteopsis ardmillanensis*, sp. nov.; *B. scotica*, Salt.

Family LICHADIDÆ. *Lichas* (*Corydocephalus*) cf. *wesenbergensis*, Schm.; *L.* (*Platylichas*) *laxatus*, M'Coy; *L.* (*Amphilichas*) *hibernicus*, Portl; *L.* (*Amphilichas*), sp.; *L.*, sp. ind. (*a*).

Family ACIDASPIDÆ. *Acidaspis grayæ*, Eth. junr.; *A. hystrix*, Wyv. Thom.; *A. lalage*, Wyv. Thom.

Family ENCRINURIDÆ. *Encrinurus punctatus* (Brünn.), var. *arenaceus*, Salt.; *Cybele* cf. *aspera*, Linn.; *C. bellatula*, Dalm.?; *C.*, sp. ind. (*a*) and (*b*); *Dindymene*? sp. ind.

Family CALYMENIDÆ. *Calymene cambrensis*, Salt.; *C.*, sp. ind. (*a*) and (*b*).

Family CHEIRURIDÆ. *Cheirurus gelasinosus*, Portl.; *C. gelasinosus*, var.?; *C.* (*Nieszkowskia*) *unicus*, Wyv. Thom.; *C.* (*Sphærocoryphe*) *thomsoni*, sp. nov; *C.* sp. ind. (*a*) and (*b*); *Sphærexochus mirus*, Beyr.; ? *Staurocephalus globiceps*, Portl.

Family PHACOPIDÆ. *Phacops* (*Pterygometopus*) *brongniarti*, Portl.

WHITEHOUSE GROUP.

Family AGNOSTIDÆ. *Agnostus perrugatus*, Barr.; *A. tardus*, Barr.

Family HARPEDIDÆ. *Harpes*, sp. ind. (*a*).

Family TRINUCLEIDÆ. *Trinucleus*, sp. ind. (*a*) to (*f*); *Ampyx depressus* (Ang.)?; *A.* cf. *scanicus* (Ang.); *Dionide lapworthi*, Eth. and Nich.; *D. richardsoni*, sp. nov.

Family OLENIDÆ. *Shumardia scotica*, sp. nov.; *Telephus fractus*, Barr.

Family ASAPHIDÆ. *Stygina latifrons* (Portl.); *Cyclopyge armata*, Barr.; *C. rediviva*, Barr.; *C.* cf. *gigantea*, Barr.; *Bohemilla*, sp.; *Illænus shallochensis*, sp. nov.

Family PROETIDÆ. *Menocephalus ?* (*Törnquistia*) cf. *nicholsoni*, Reed.

Family LICHADIDÆ. *Lichapyge ? problematica*, sp. nov.

Family ACIDASPIDÆ. *Acidaspis dalecarlica*, Törnq.?

Family ENCRINURIDÆ. *Encrinurus multisegmentatus*, Portl.; *Dindymene cordai*, Eth. and Nich.

Family CHEIRURIDÆ. *Cheirurus* (*Sphærocoryphe*) *thomsoni*, sp. nov.

DRUMMUCK GROUP.

Family AGNOSTIDÆ. *Agnostus agnostiformis*, M'Coy.

Family TRINUCLEIDÆ. *Trinucleus bucklandi*, Barr.; *Ampyx drummuckensis*, sp. nov.; *Dionide richardsoni*, sp. nov.

Family OLENIDÆ. *Remopleurides colbii*, Portl.?; *R.* cf. *platyceps*, M'Coy.

Family ASAPHIDÆ. *Illænus bowmani*, Salt.?; *I. bowmani*, var. *longicapitatus*, Reed; *I. extensus*, sp. nov.; *I. shallochensis*, sp. nov.

Family PROETIDÆ. *Proetus girvanensis*, Eth. and Nich.; *P. procerus*, Eth. and Nich.; *Phillipsinella parabola*, Barr.; *Cyphaspis megalops*, M'Coy.

Family LICHADIDÆ. *Lichas* (*Corydocephalus*) *geikiei*, Eth. and Nich.; *L.* (*Metopolichas*) *bulbiceps*, Phill. var.; *L.* (*Platylichas*) *laxatus*, M'Coy; *L.* (*Conolichas*) cf. *æquiloba*, Steinh.

Family ENCRINURIDÆ. *Encrinurus multisegmentatus*, Portl.; *Cybele loveni*, Linn., var. nov. *girvanensis*. *Dindymene cordai*, Eth. and Nich.

Family CALYMENIDÆ. *Calymene blumenbachi*, var. nov. *drummuckensis*.

Family CHEIRURIDÆ. *Cheirurus bimucronatus*, Murch.; *C.* (*Cyrtometopus*) *octolobatus*, M'Coy; *C.* (*Sphærocoryphe*) *thomsoni*, sp. nov.; *Staurocephalus globiceps*, Portl.

Family PHACOPIDÆ. ? *Phacops* (*Pterygometopus*) *brongniarti*, Portl.; *Phacops* (*Chasmops*) *bisseti*, sp. nov.

SILURIAN.

Mulloch Hill Group.

Family Asaphidæ. *Illænus macallumi*, Salt.; *I. nexilis*, Salt.; *I. thomsoni*, Salt.

Family Proetidæ. *Proetus latifrons*, M'Coy; *P. stokesi*, Murch.; *P.* cf. *obconicus*, Lindstr.; *P.*, sp. ind. (*a*); *Cyphaspis megalops*, M'Coy?

Family Lichadidæ. *Lichas* (*Corydocephalus*) *scutalis*, Salt.; *L.* (*Platylichas*) *grayi*, Fletch., var. nov. *scoticus; L grayi*, var. ind.

Family Acidaspidæ. *Acidaspis callipareos*, Wyv. Thom.; *A. coronata*, Salt.; *A. deflexa*, Lake.

Family Encrinuridæ. *Encrinurus punctatus* (Brünn.), var. *arenaceus.*

Family Calymenidæ. *Calymene blumenbachi*, Brong.

Family Cheiruridæ. *Deiphon forbesi*, Barr.

Family Phacopidæ. *Phacops* (*Phacopidella*) *elegans* (Sars and Boeck).

Saugh Hill Group.

Family Asaphidæ. *Illænus æmulus*, Salt. var.; *I. barriensis*, Murch.; *I. thomsoni*, Salt.; *I. nexilis*, Salt.

Family Proetidæ. *Proetus latifrons*, M'Coy; *P. stokesi*, Murch.; *P.* cf. *obconicus*, Lindstr.

Family Bronteidæ. *Bronteus andersoni*, Eth. and Nich.

Family Lichadidæ. *Lichas* (*Corydocephalus*) *scutalis*, Salt.; *L.* (*Platylichas*) *grayi*, Fletch., var. nov. *scoticus*; *L.* (*Metopolichas*) aff. *marginatus*, Lindstr.

Family Acidaspidæ. *Acidaspis callipareos*, Wyv. Thom.; *A. coronata*, Salt.

Family Encrinuridæ. *Encrinurus punctatus* (Brünn.), var. *calcareus* and var. *arenaceus.*

Family Calymenidæ. *Calymene blumenbachi*, Brong.

Family Cheiruridæ. *Cheirurus bimucronatus*, Murch.

Family Phacopidæ. *Phacops* (*Phacopidella*) *downingiæ*, Murch.?; *P.* (*Phacopidella*) *elegans* (Sars and Boeck).

Camregan Group.

Family Harpedidæ. *Harpes*, sp. ind. (*b*).

Family Asaphidæ. *Illænus æmulus*, Salt. var.; *I. barriensis*, Murch.; *I. thomsoni*, Salt.

Family Proetidæ. *Proetus pseudolatifrons*, sp. nov.; *P. stokesi*, Murch.

Family Bronteidæ. *Bronteus andersoni*, Eth. and Nich.

Family Lichadidæ. *Lichas* (*Platylichas*) *grayi*, Fletch., var. nov., *scoticus.*

Family Acidaspidæ. *Acidaspis coronata*, Salt.

Family Encrinuridæ. *Encrinurus punctatus* (Brünn.), var. *calcareus.*

Family Cheiruridæ. *Cheirurus bimucronatus*, Murch.

Family Phacopidæ. *Phacops* (*Phacopidella*) *elegans* (Sars and Boeck).

Penkill Group.

Family Asaphidæ. *Illænus æmulus*, Salt. and var.; *I. barriensis*, Murch.; ? *I. nexilis*, Salt.; *I. thomsoni*, Salt.

Family Proetidæ. *Proetus stokesi*, Murch.

Family Bronteidæ. *Bronteus andersoni*, Eth. and Nich.
Family Acidaspidæ. *Acidaspis barrandei*, Fletch. and Salt.
Family Encrinuridæ. *Encrinurus punctatus* (Brünn.), var. *calcareus*.
Family Calymenidæ. *Calymene blumenbachi*, Brong.
Family Cheiruridæ. *Cheirurus* (*Youngia*) *trispinosus*, Young.
Family Phacopidæ. *Phacops* (*Phacopidella*) *elegans* (Sars and Boeck).

Bargany Group.

Family Encrinuridæ. *Encrinurus punctatus* (Brünn.), var. *calcareus*.

Wenlock Group.

Family Lichadidæ. *Lichas* (*Corydocephalus*) *anglicus*, Beyr.
Family Encrinuridæ. *Encrinurus punctatus* (Brünn.), var. *calcareus*.
Family Phacopidæ. ? *Phacops* (*Phacopidella*) *downingiæ*, Murch.

GENERAL REMARKS.

The trilobitic fauna of the Lower Palæozoic beds of the Girvan area shows certain marked characteristics which call for notice. Firstly, there is the occurrence of certain peculiar genera or subgenera known at present from no other region. Such are *Bronteopsis* and *Teratorhynchus*. Secondly, some of the genera and subgenera are not found elsewhere in the British Isles, though occurring in other parts of the world. The Bohemian genera *Telephus*, *Bohemilla*, and *Arethusina* are included in this category, and the North European subgenera *Nieszkowskia* and *Youngia*. Thirdly, there are several generic constituents which, though not unknown from other Lower Palæozoic regions in the British Isles, are decidedly uncommon and rare; such are *Apatokephalus*, *Dionide*, *Salteria*, *Törnquistia*, *Dindymene*, and *Sphærocoryphe*. We may further note the unusual stratigraphical horizons at which certain of the genera occur. Thus *Shumardia* and *Triarthrus* occur here higher than is typically the case, while *Arethusina* and *Törnquistia* are represented at an earlier stage than usual.

The occurrence of some forms identical with foreign and not British species is likewise remarkable (*e.g. Agnostus perrugatus*, *Cyclopyge armata*, etc.), while others are less allied to members of English Palæozoic faunas than to members of continental faunas. It is thus seen that the Girvan trilobitic fauna is composed of several diverse elements.

Local Species.—The large proportion of species peculiar to the locality first attracts our attention; even omitting doubtful or indeterminable species and

varieties, we can enumerate the following thirty-six species as peculiar to the Girvan area out of a total of 110 determinable or comparable species:

Agnostus girvanensis,
Trinucleus subradiatus,
Ampyx drummuckensis,
,, *hornei,*
,, *macallumi,*
,, *incurvus,*
Dionide lapworthi,
,, *richardsoni,*
Remopleurides barrandei,
,, *(Teratorhynchus) bicornis,*
,, *correctus,*
Shumardia scotica,
Salteria primæva,
Asaphus instabilis,
Illænus balclatchiensis,
,, *extensus,*
,, *shallochensis,*
,, *macallumi,*
Illænus memorabilis,
Proetus girvanensis,
,, *procerus,*
Bronteus andersoni,
,, *craigensis,*
,, *grayi,*
Bronteopsis ardmillanensis,
,, *scotica,*
Lichas (Corydocephalus) geikiei,
Acidaspis callipareos,
,, *grayæ,*
,, *hystrix,*
,, *lalage,*
Dindymene cordai,
Cheirurus (Nieszkowskia) unicus,
,, *(Sphærocoryphe) thomsoni,*
,, *(Youngia) trispinosus,*
Phacops (Chasmops) bisseti.

If we were to include the forms which are at present too imperfectly known to be specifically designated, the number would be still larger.

British Species.—The second principal element of the Girvan trilobitic fauna consists of the species occurring elsewhere in the British Isles, and it includes the following:

Agnostus agnostiformis,
Harpes flanagani,
Trinucleus bucklandi,
Remopleurides colbii,
,, *dorsospinifer,*
,, *longicostatus,*
,, *salteri,*
Asaphus gigas,
Stygina latifrons,
**Illnæus æmulus,*
* ,, *barriensis,*
? ,, *bowmani,*
? ,, *davisi,*
,, *latus,*
? ,, *murchisoni,*
* ,, *nexilis,*
Illænus portlocki,
* ,, *thomsoni,*
**Proetus latifrons,*
* ,, *pseudolatifrons,*
* ,, *stokesi,*
**Cyphaspis megalops,*
Phillipsinella parabola,
**Lichas anglicus,*
* ,, *scutalis,*
*? ,, *grayi,*
,, *bulbiceps,*
,, *hibernicus,*
**Acidaspis barrandei,*
* ,, *coronata,*
* ,, *deflexa,*
**Encrinurus punctatus,*
,, *multisegmentatus,*
? *Cybele verrucosa,*
**Calymene blumenbachi,*
,, *cambrensis,*
,, *planimarginata,*
Cheirurus bimucronatus,
,, *gelasinosus,*
,, *octolobatus,*
**Deiphon forbesi,*
Sphærexochus mirus,
Staurocephalus globiceps,
Phacops brongniarti,
*? ,, *downingiæ,*
* ,, *elegans.*

(*N.B.*—The Silurian species are marked *.)

Thus forty-six species (or omitting the six doubtful ones, only forty species) are common to the Scottish and other British areas. This is only a few

more than the definitely determined peculiar Girvan species. There have been described in the preceding memoir 135 distinct species and several varieties; and even if we cut out those which cannot be identified or compared with described forms from any region, we still are left with less than one third of the whole number of species which are known from other localities in the British Isles. The local Girvan element has been shown to form nearly as large a proportion of the whole. Moreover, it cannot fail to be noticed that, considering the relative abundance of species in the Ordovician and Silurian beds, the majority of the typical British forms do not appear till Silurian times. Out of the total number of twenty-seven Silurian species recorded in the Girvan area there are nineteen British species, as the above list shows; while out of the total eighty-three determinable Ordovician species of Girvan there are only about twenty-five occurring elsewhere in the British Isles, and many of these are rare or occur typically only in Ireland. The proportion of the British element is therefore much larger in Silurian times than it was in Ordovician times, and seems to indicate a sudden inrush of species from the south at the beginning of the Llandovery period by the breaking down or removal of some intervening barrier.

Foreign Elements.—The two elements of the trilobitic fauna which have been above mentioned are not the only ones which can be isolated. There is a distinct Bohemian element represented by the following species: *Agnostus perrugatus*, *A. tardus*, *Telephus fractus*, *Cyclopyge armata*, *C. rediviva*, *Bohemilla*, sp., *Arethusina konincki*. With the exception of the last-named species they are confined to one horizon—the Whitehouse Group.

The Baltic or North European element is more widely distributed, ranging through the whole Ordovician, and is represented not so much by identical species as by allied species or by others belonging to some of its peculiar genera *Nieszkowskia*, *Sphærocoryphe*, *Youngia*, etc. We may enumerate the following forms:

Ampyx depressus ?
,, cf. *foveolatus*,
,, cf. *scanicus*,
Apatokephalus sp. (also in S. Ireland),
Remopleurides cf. *nanus*,
Illænus cf. *oculosus*,
Proetus cf. *obconicus*,
Lichas aff. *marginatus*,
Lichas (*Conolichas*) cf. *æquiloba*,
Acidaspis dalecarlica,
Cybele cf. *aspera*,
,, *bellatula ?*
Cheirurus (*Nieszkowskia*) *unicus*,
,, (*Sphærocoryphe*) *thomsoni*,
,, (*Youngia*) *trispinosus*.

Individuality of the Fauna.—In spite of the various constituent elements of the trilobitic fauna, its individuality is strongly marked by the number of its peculiar species and the presence of two peculiar genera. The individual character which it thus possesses is most conspicuous during Ordovician times, the local element

being almost absent on entering the Silurian period, when the general features of the common British fauna overspread the area.

Geographical Distribution.—The recognition of more or less distinct zoogeographical marine provinces in Europe in the distribution of trilobites during Lower Palæozoic times is mainly due to Frech;[1] and though recent work has rendered some modification necessary in his lists of peculiar genera or subgenera supposed to be characteristic of the several provinces, yet the main principles may be regarded as well established. The existence, in fact, of four distinct provinces is supported by an ever-increasing amount of evidence. To what extent these geographical divisions hold good with respect to other zoological groups of organisms during the same period remains largely still uninvestigated.

The British Isles belong, according to Frech's scheme, to the North Atlantic marine province, the Baltic and Bohemian-Mediterranean provinces being distinct. The invasion of England by Baltic forms has been referred to by me on a former occasion,[2] but the genus *Nieszkowskia* has not been mentioned previously in this connection. The contingent from the Bohemian province in the Whitehouse Beds is of much interest (apart from *Arethusina konincki*?, which occurs in the Balclatchie Beds); it appears and disappears with equal suddenness.

The relation of the trilobitic fauna of the Pomeroy and Waterford areas to that of the Girvan district is deserving of notice. In the case of the Waterford area the presence of a Scandinavian element has been pointed out;[3] and there is a resemblance, though faint, in the Waterford and Girvan trilobites, as shown by the occurrence of the rare genus *Apatokephalus* (= *Tramoria*) and of allied or comparable species, apart from widely distributed British species, such as *Phacops brongniarti*. The Drummuck Beds in the Girvan area contain several species identical with those of Keisley and Kildare (*e.g. Lichas bulbiceps, Remopleurides colbii, Phillipsinella parabola*, etc.), but with the possible exception of the first mentioned, all these species occur elsewhere. The Scandinavian element at Keisley has been elsewhere referred to as especially strong, but it is less prominent at Drummuck. The characteristic species of this horizon of the Bala series have a remarkably wide horizontal distribution.

But on the whole the communication between the different basins of deposition in Ordovician times in Europe, and even in the British Isles, seems to have varied irregularly in degree and in duration. The determining factors in the migrations, counter-migrations, and interchange of faunas were undoubtedly physical to a large extent, but we must not forget that biological influences, the importance of which it is at present impossible to estimate when dealing with fossil faunas, were probably also at work, and may ultimately help to explain the many puzzling

[1] Frech, 'Leth. Palæoz.,' vol. ii (1897), pp. 88—95.

[2] Reed, 'Quart. Journ. Geol. Soc.,' vol. liii (1897), pp. 96—100.

[3] Reed, 'Quart. Journ. Geol. Soc.,' vol. lv (1899), pp. 768—770.

sudden appearances and disappearances of the foreign species in British areas and the seemingly sporadic distribution of certain types.

Vertical Range of Genera.—Apart from the general characters of the whole assemblage of trilobites in the Girvan area we may notice certain peculiarities of stratigraphical distribution. Thus the restriction of the genus *Bronteus* to the Stinchar Limestone Group in the Ordovician is remarkable, and it is the earliest known occurrence of the genus in the British Isles. A species from the Upper Bala of Kildare, *B. andersoni* from the Saugh Hill, Camregan, and Penkill Groups, and another from the Wenlock Limestone of Dudley, are the only other representatives of the genus till we reach the Devonian, where its maximum development takes place. The allied genus *Bronteopsis* appears to be confined to the Balclatchie Group, and is only known in the Girvan area.

The large number and variety of species belonging to the genus *Illænus* is a feature on every stratigraphical horizon; but, unlike *Bronteus* and *Bronteopsis*, the species are represented by abundant individuals in nearly every case.

Remopleurides occupies a much more prominent position than is usual, and in the Balclatchie Group members of the species *R. barrandei* and *R. salteri* and of the peculiar *Teratorhynchus bicornis* are very numerous.

Certain genera, or even families, are, on the other hand, much less developed than on corresponding horizons in England and Wales. Thus the genus *Asaphus* is only represented by two species, and these are confined to the two lowest groups of beds—the Stinchar Limestone and Balclatchie Groups; and the Phacopidæ are rare in genera, species, and individuals; the genus *Dalmanites*, in fact, is totally wanting.

The vertical distribution of the genera and species is illustrated in the following table, the occurrence of each species being indicated by a cross ×. This table thus indicates the relative development of the different genera on the successive stratigraphical horizons, and brings conspicuously forward some interesting facts with regard to vertical range and variable representation. The Ardwell Group, the Barren Flagstone Group, and the Drumyork Group are omitted from the list of formations as they have so far yielded no trilobites. It must be remembered that the dominant genera of trilobites, as expressed by the number of species in each stratigraphical division, do not necessarily correspond with the dominant species of trilobites as indicated by the abundance of individuals. Statistics are not available to determine the "frequency values" of the various species;[1] and although without special collecting with this object in view we cannot give a true and connected account of the development, movements, and adjustments of the trilobites in the Girvan area through the Ordovician and Silurian periods, yet certain changes in the proportionate specific representation of the genera and in

[1] Williams, 'Bull. 210, U.S. Geol. Surv.' (1903), pp. 10—41.

their temporary invasion or desertion of the basin of deposition may be gathered from an inspection of the following table.

Genera.	Stinchar Limestone Group.	Balclatchie Group.	Whitehouse Group.	Drummuck Group.	Mulloch Hill Group.	Saugh Hill Group.	Camregan Group.	Penkill Group.	Bargany Group.	Blair, Knockgardner, and Straiton Beds.
Agnostus		×	× ×	×						
Harpes	× ×	×	×				×			
Trinucleus	×	× ×	× × × × × ×	×						
Ampyx	×	× × × ×	× ×	×						
Dionide			× ×	×						
Triarthrus		×								
Apatokephalus		×								
Remopleurides	×	× × × × ×		× ×						
— (*Teratorhynchus*)		×								
Shumardia			×							
Salteria		×								
Telephus			×							
Asaphus	×	× ×								
Stygina			×							
Cyclopyge			× × ×							
Bohemilla			×							
Illænus	× × × × × ×	× × ×	×	× × ×	× × ×	× × × ×	× × ×	× × × ×		
Proetus				× ×	× × × ×	× × ×	× ×	×		
Cyphaspis				×	×					
Arethusina		×								
Phillipsinella				×						
Menocephalus (*Törnquistia*)		×								
Bronteus	× × × ×					×	×	×		
Bronteopsis	×	× ×								
Lichas (*Corydocephalus*)		×		×	×	×				×
— (*Platylichas*)		×		×	×	×	×			
— (*Metopolichas*)				×		×				
— (*Amphilichas*)	×	× ×								
— (*Conolichas*)				×						
Lichapyge ?			×							
Acidaspis		× × ×	×		× × ×	× ×	×	×		
Encrinurus	×	×	×	×	×	×	×	×	×	×
Cybele	× ×	× × × ×		×						
Dindymene		× ?	×	×						
Calymene	×	× × ×		×	×	×		×		
Cheirurus	×	×		×		×	×			
— (*Cyrtometopus*)				×						
— (*Nieszkowskia*)		×								
— (*Sphærocoryphe*)		×	×	×						
— (*Youngia*)								×		
Deiphon					×					
Sphærexochus	×	×								
Staurocephalus		× ?		×						
Pliomera	×									
Phacops (*Pterygometopus*)	×	×		×						
— (*Phacopidella*)					×	× ×	×	×		×
— (*Chasmops*)				×						

In the Stinchar Limestone Group we notice 16 genera and sub-genera present, containing 26 species. The genera *Illænus* and *Bronteus* comprise more than one third of the number of species, and *Illænus* appears also to be the richest in individuals.

In the Balclatchie Group 26 or possibly 28 genera occur with 46 (or 48) species. *Remopleurides*, *Acidaspis*, and *Ampyx* take the lead.

In the Whitehouse Group there are 16 genera recorded and 26 species (or

perhaps only 24 species if we cut out two of the doubtful *Trinucleus*). The predominant genus is undoubtedly *Trinucleus*. Several rare and curious genera only occur on this horizon, and it is remarkable that the genus *Cyclopyge* is only known from these beds in the Girvan district, while in England and Wales it characterises lower horizons.

The Drummuck Group has yielded 23 genera with 27 species. We get here the typical Upper Bala facies of the North of England, with *Staurocephalus globiceps*, *Trinucleus bucklandi*, *Phillipsinella parabola*, etc. But some peculiar genera and species occur. Most of the genera are represented by only one species, and it is difficult to say which is the most abundant species.

In the Mulloch Hill Group the number of genera has decreased to 10, containing 17 species. *Illænus* is prominent and so is *Acidaspis*, but *Proetus* is perhaps no less conspicuous. As regards the abundance of individuals the species of *Illænus* are undoubtedly first.

The Saugh Hill Group contains 11 genera with 18 species. With the exception of the reappearance of *Bronteus* after a long absence from this area the trilobitic fauna much resembles that of the Mulloch Hill Group.

In the Camregan Group there are 9 genera. *Harpes* reappears. There are 12 species present.

The Penkill Group has only yielded 8 genera and sub-genera. *Youngia* is peculiar to it. *Illænus* is again the dominant genus and most abundant in individuals.

The Bargany Group has only yielded one genus with one species; and the Blair, Knockgardner, and Straiton Beds three genera, each with one species.

The most persistent genus in the Girvan area is seen to be *Encrinurus*, but *Illænus* comes second. The same species of *Encrinurus*, represented by two varieties, is found in nearly every stratigraphical group. Many genera or sub-genera, on the other hand, are restricted to one formation. This is especially the case in the Whitehouse Group, which boasts six peculiar genera; and the same number of genera or sub-genera is confined to the Balclatchie Group.

INDEX.

PLATE XIV.

Fig. | | Page.

Lichas (Corydocephalus) geikiei, Nicholson and Etheridge. 96.

1. Pygidium. × 5. Starfish Bed, Thraive Glen. Mrs. Gray's Collection.

Lichas (Corydocephalus) cf. **wesenbergensis,** Schmidt. 98.

2. Pygidium. × 5. Dow Hill. Sedgwick Museum.

Lichas (Corydocephalus) scutalis, Salter. 98.

3. Glabella. × 3. Newlands. Mrs. Gray's Collection.
4. Pygidium. × 3. Same locality and Collection.

Lichas (Platylichas) grayi, var. nov. **scoticus.** 100.

5. Head-shield. × $2\frac{1}{2}$. Mulloch Hill. Mrs. Gray's Collection.

5a. Front view of same specimen. × $2\frac{1}{2}$.

6. Ditto, another specimen. × 3. Same locality and Collection.

6a. Side view of same specimen. × 3.

7. Hypostome. × $2\frac{1}{2}$. Rough Neuk, Mulloch Hill. Same Collection.
8. Pygidium. × 2. Mulloch Hill. Museum of Practical Geology.
9. Ditto. × 3. Craigens. Mrs. Gray's Collection.
10. Imperfect head-shield, doubtfully referred to this species. × $1\frac{1}{2}$. Camregan Wood. Mrs. Gray's Collection.

Lichas (Platylichas) laxatus, M'Coy. 102.

11. Imperfect thorax and pygidium. × $1\frac{1}{2}$. Thraive Glen. Mrs. Gray's Collection.
12. Hypostome attached to same individual and in position. × 2.
13. Imperfect individual, showing head and thorax. × $1\frac{1}{2}$. Same locality and Collection.

13a. Eye of same specimen, side view. × 4.

13b. Portion of surface of same eye, showing lenses. × 20.

Lichas (Metopolichas) bulbiceps, Phillips MS. 104.

14. Head-shield. × 3. Starfish Bed, Thraive Glen. Mrs. Gray's Collection.

Lichas (Metopolichas) aff. **marginatus,** Lindström. 104.

15. Head-shield. × $1\frac{1}{2}$. Woodland Point. Mrs. Gray's Collection.
16. Hypostome, probably belonging to this species. × 2. Same locality and Collection.

Reed, Girvan Trilobites.

PLATE XIV.

G. M. Woodward del et lith.

West, Newman imp

LICHAS

PLATE XV.

Fig. Page.

Lichas (Amphilichas) hibernicus (Portlock). 106.

1. Glabella. × $1\frac{1}{2}$. Craighead. Mrs. Gray's Collection.
2. Imperfect head-shield. × 2. Balclatchie. Mrs. Gray's Collection. (Figured by Nicholson and Etheridge, *op. cit.*, fasc. i, pl. ix, fig. 10.)
3. Hypostome. × 2. Same locality and Collection.

Lichas (Amphilichas), sp. 109.

4. Imperfect glabella. Nat. size. Dow Hill. Mrs. Gray's Collection.
5. Portion of pleura. × 2. Same locality and Collection.

Lichas (Conolichas) cf. **æquiloba,** Steinhardt. 109.

6. Imperfect head-shield. × 5. Starfish Bed, Thraive Glen. Mrs. Gray's Collection.

Lichas, sp. ind. 110.

7. Imperfect head-shield. × 5. Balclatchie (conglomerate). Mrs. Gray's Collection.

Lichapyge ? problematica, sp. nov. 110.

8. Pygidium with three thoracic segments. × 7. Whitehouse Bay. Mrs. Gray's Collection.
9. Ditto. × 7. Same locality and Collection.
10. Ditto. × 7. Same locality and Collection.

Acidaspis barrandei, Fletcher and Salter. 112.

11. Imperfect head-shield. Nat. size. Penkill. Mrs. Gray's Collection.

Acidaspis callipareos, Wyv. Thomson. 112.

12. Imperfect head-shield. × 2. Woodland Point. Mrs. Gray's Collection.
13. Outline restoration from figure given by Wyv. Thomson in 'Quart. Journ. Geol. Soc.,' vol. xiii, 1857, pl. vi, fig. 11.

Acidaspis coronata, Salter. 113.

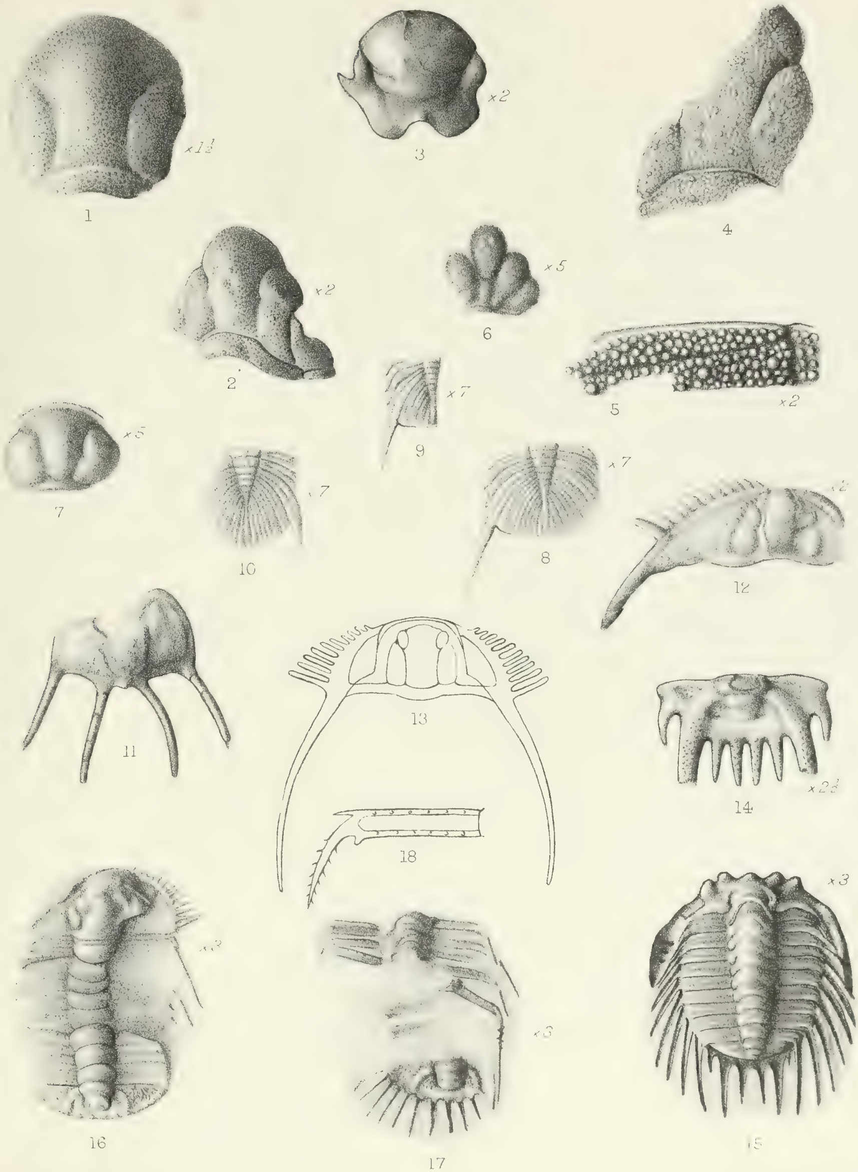
14. Pygidium. × $2\frac{1}{2}$. Woodland Point. Mrs. Gray's Collection.

Acidaspis deflexa, Lake. 113.

15. Complete individual. × 3. Rough Neuk. Mrs. Gray's Collection.

Acidaspis grayæ, R. Etheridge. 114.

16. Nearly complete individual. × 3. Balclatchie. Mrs. Gray's Collection. (Figured by Nicholson and Etheridge, *op. cit.*, fasc. i, pl. viii, fig. 26.)
17. Ditto. × 3. Showing pygidial spines. Same locality and Collection.
18. Outline restoration of pleura, showing terminal spines.



G.M. Woodward del et lith. West, Newman imp.

LICHAS, LICHAPYGE. ACIDASPIS.

PLATE XVI.

Fig. | Page.

Acidaspis grayæ, R. Etheridge. 114.

1. Pygidium. × 3. Balclatchie. Mrs. Gray's Collection.
2. Head-shield. × 4. Same locality and Collection. (Figured by Nicholson and Etheridge, pl. viii, fig. 18, as *A. lalage*.)

Acidaspis hystrix, Wyv. Thomson. 116.

3. Incomplete individual. × 4. Balclatchie. Mrs. Gray's Collection.
4. Pygidium. × 6. Same locality and Collection.
5. Portion of thorax with pygidium attached. × 6. Same locality and Collection.

Acidaspis lalage, Wyv. Thomson. 117.

6. Head-shield. × 6. Balclatchie. Mrs. Gray's Collection. (Figured by Nicholson and Etheridge, *op. cit.*, fasc. i, pl. viii, fig. 21.)

Acidaspis cf. **dalecarlica**, Törnquist. 119.

7. Pygidium. × 4. Shalloch Mill. Mrs. Gray's Collection.

Encrinurus punctatus (Brünnich), var. **arenaceus**, Salter. 120.

8. Pygidium. × 3. Minuntion. Mrs. Gray's Collection.

Encrinurus multisegmentatus (Portlock). 122.

9. Portion of head-shield and of thorax. × 2½. Starfish Bed, Thraive Glen. Mrs. Gray's Collection.
10. Imperfect head-shield and thorax. × 2. Same locality and Collection.
11. Nearly complete individual, partly enrolled. × 2½. Same locality and Collection.

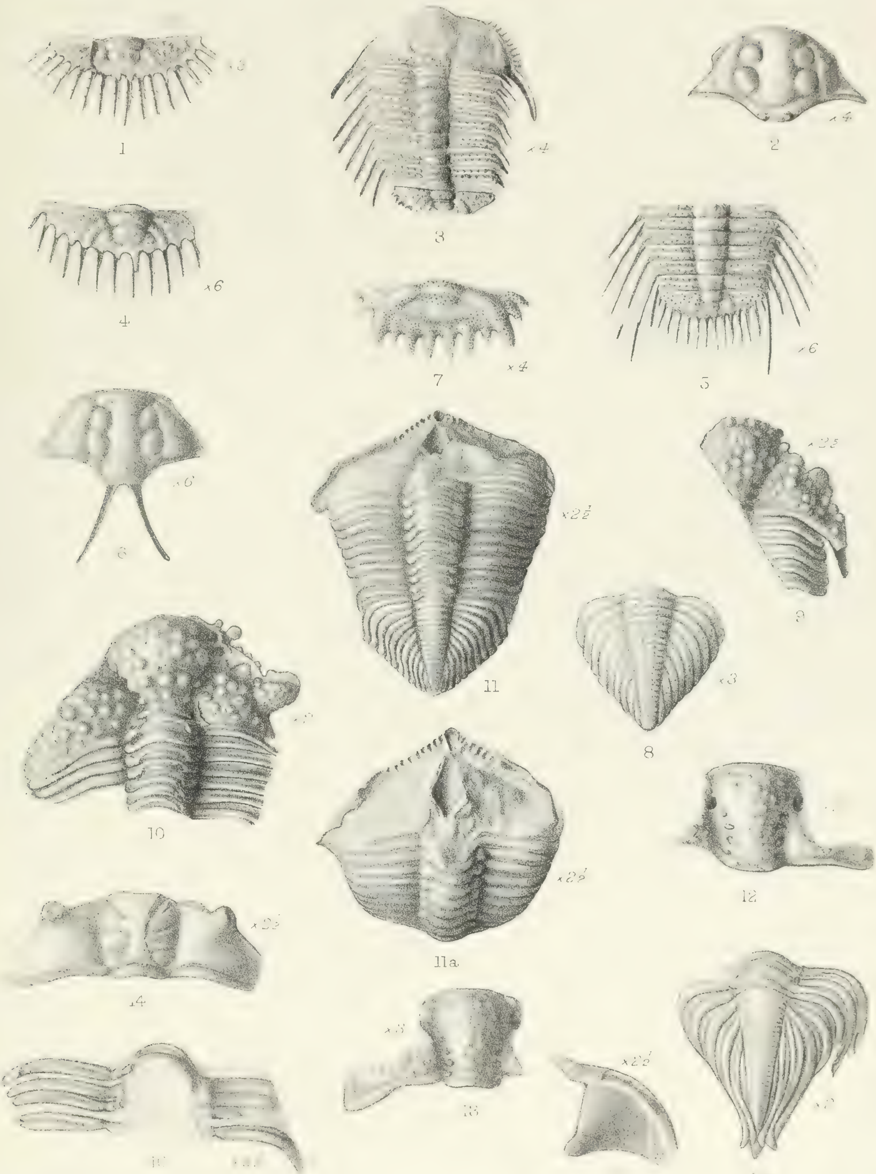
11*a*. Same specimen, showing margin of head-shield and position of hypostome. × 2½.

Cybele cf. **aspera**, Linnarsson. 128.

12. Head-shield. × 2½. Ardmillan. Mrs. Gray's Collection.
13. Ditto, showing genal angle. × 3. Dow Hill. Same Collection.

Cybele bellatula (Dalman). 124.

14. Head-shield. × 2½. Dow Hill. Mrs. Gray's Collection.
15. Portion of thorax with pygidium. × 2. Same locality and Collection.
16. Four thoracic rings. × 2½. Same locality and Collection.
17. Free cheek, probably belonging to this species. × 2½. Same locality and Collection.



G. M. Woodward del. et lith. West, Newman

ACIDASPIS, ENCRINURUS, CYBELE.

PLATE XVII.

Fig. | Page.

Cybele loveni, var. nov. **girvanensis.** 126.

1. Head-shield with a few thoracic segments attached. × $1\frac{1}{2}$. Thraive Glen. Mrs. Gray's Collection.

1*a*. Same specimen, viewed from behind. × $1\frac{1}{2}$.

2. Another specimen of complete enrolled individual. × $2\frac{1}{2}$. Same locality and Collection.

2*a*. Same specimen, showing posterior part of thorax and pygidium. × $2\frac{1}{2}$.

3. Another specimen, showing genal spine and produced pleuræ of 6th thoracic segment. × $1\frac{1}{2}$. Same locality and Collection.

4. Pygidium of another individual. × 2. Same locality and Collection.

Cybele, sp. ind. (*a*). 130.

5. Head-shield. × $2\frac{1}{2}$. Balclatchie. Mrs. Gray's Collection. (Figured by Nicholson and Etheridge, *op. cit.*, fasc. ii, p. 203, pl. xiv, fig. 12, as *Cheirurus*? sp. ind.)

Cybele, sp. ind. (*b*). 130.

6. Imperfect head-shield. × 3. Dow Hill. Mrs. Gray's Collection.

7. Impression of another head-shield. × 3. Ardmillan. Same Collection.

8. Pygidium, probably belonging to this species. × 5. Dow Hill. Same Collection.

Dindymene cordai, Etheridge and Nicholson. 132.

9. Complete individual. × 3. Thraive Glen. Mrs. Gray's Collection.

10. Imperfect specimen, showing pygidium and thorax. × 3. Same locality and Collection.

11. Imperfect head-shield, showing front margin. × 3. Same locality and Collection.

Calymene blumenbachi, Brongniart. 133.

12. Head-shield. × $2\frac{1}{2}$. Mulloch Hill. Mrs. Gray's Collection.

13. Head-shield of variety. × $2\frac{1}{2}$. Newlands. Same Collection.

Calymene blumenbachi, var. nov. **drummuckensis.** 135.

14. Hypostome. × 3. Thraive Glen. Mrs. Gray's Collection.

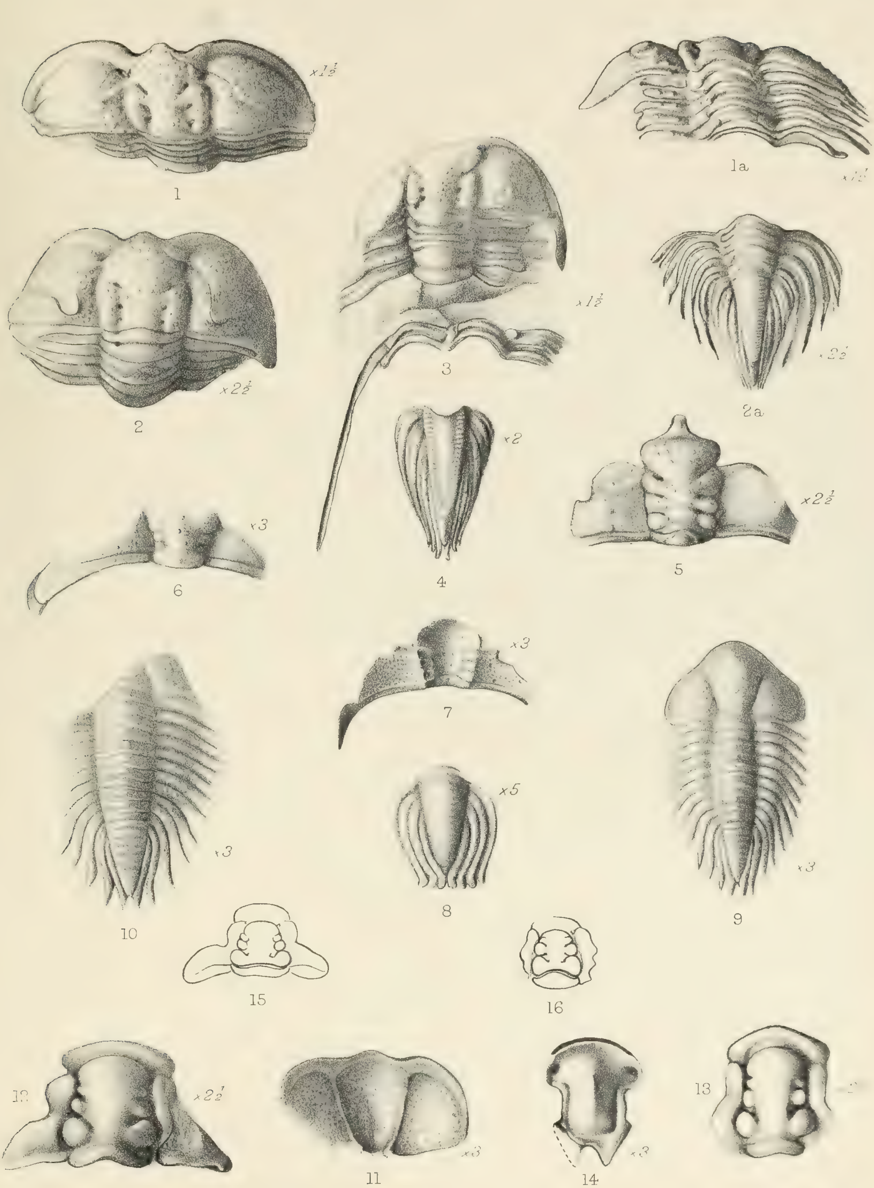
Calymene planimarginata, sp. nov. 137.

15. Outline tracing from Salter's figure of *C. senaria* ('Mon. Brit. Trilob.,' pl. ix, fig. 8).

Calymene cambrensis, Salter. 136.

16. Outline tracing from Salter's figure, *op. cit.*, pl. ix, fig. 12.

Reed, Girvan Trilobites. PLATE XVII.



G.M. Woodward del. et lith. West, Newman imp.

CYBELE, DINDYMENE, CALYMENE.

PLATE XVIII.

Fig. | Page.

Calymene blumenbachi, var. nov. **drummuckensis.** 135.

1. Head-shield. Nat. size. Thraive Glen (Starfish Bed). Mrs. Gray's Collection.
2. Complete individual. Nat. size. Same locality and Collection.
3. Head-shield. × $1\frac{1}{2}$. Same locality and Collection.
4. Pygidium. Nat. size. Same locality and Collection.

Cheirurus gelasinosus (Portlock). 140.

5. Glabella. Nat. size. Craighead. Mrs. Gray's Collection.
6. Some thoracic segments. Nat. size. Same locality and Collection.

Cheirurus gelasinosus, var. ?. 141.

7. Glabella. × $2\frac{1}{2}$. Balclatchie. Museum of Practical Geology.

Cheirurus (Cyrtometopus) octolobatus (M'Coy). 141.

8. Part of thorax with pygidium attached. × 2. Thraive Glen. Mrs. Gray's Collection.

8*a*. Three anterior thoracic segments of same specimen. × 2.

9. Head-shield. × $1\frac{1}{2}$. Same locality and Collection.
10. Head-shield. Nat. size. Same locality and Collection.
11. Pygidium. × $2\frac{1}{2}$. Same locality and Collection.

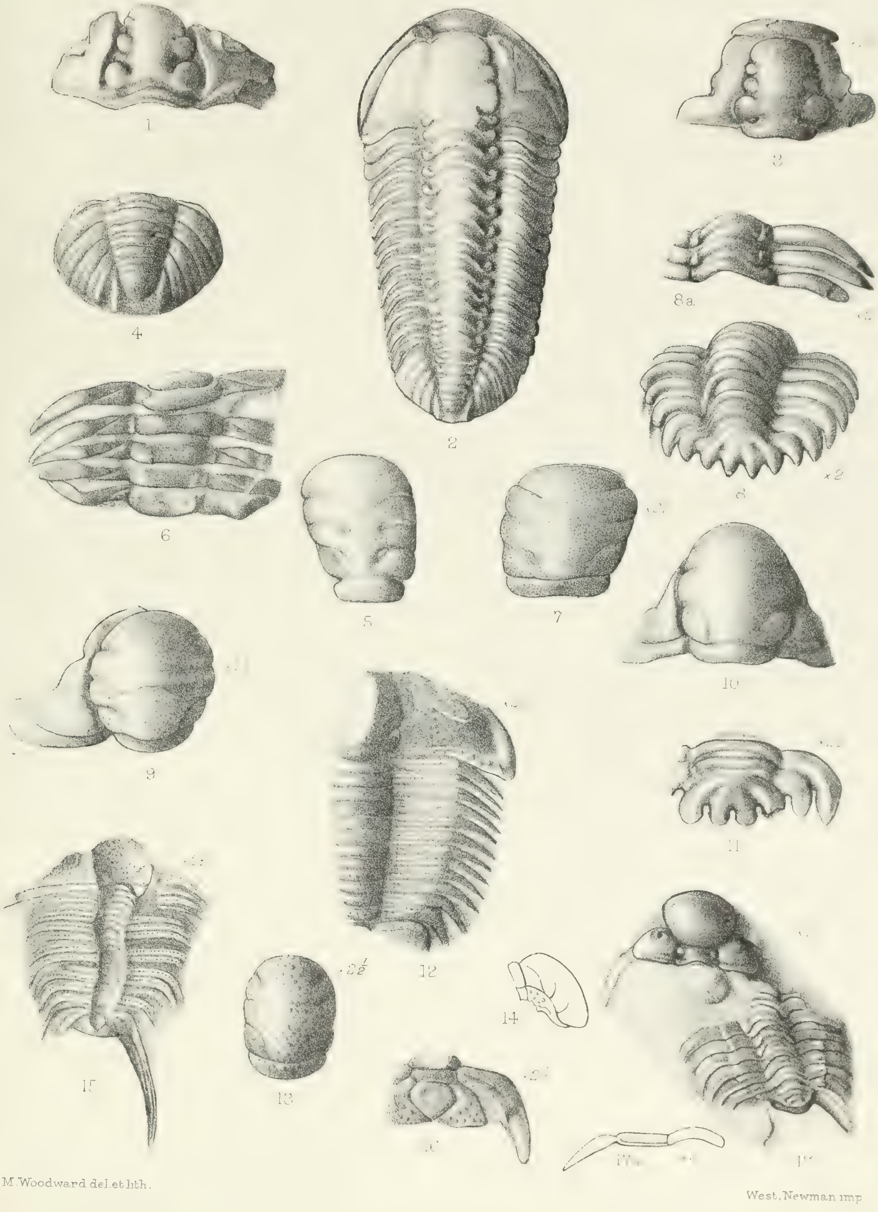
Cheirurus (Nieszkowskia) unicus (Wyville Thomson). 142.

12. Nearly complete individual. × $2\frac{1}{2}$. Balclatchie. Mrs. Gray's Collection.
13. Glabella. × $2\frac{1}{2}$. Same locality and Collection.
14. Outline drawing of side view of head-shield, to show downward bending of same.
15. Nearly complete individual, showing pygidium. × $2\frac{1}{2}$. Same locality and Collection. (Figured by Nicholson and Etheridge, *op. cit.*, fasc. i, pl. viii, fig. 10.)
16. Pygidium. × $2\frac{1}{2}$. Same locality and Collection.

Cheirurus (Sphærocoryphe) thomsoni, sp. nov. 146.

17. Imperfect individual, showing head-shield and pygidium. × 2. Thraive Glen. Mrs. Gray's Collection.

17*a*. Outline restoration of thoracic pleura of same. × 3.



G. M. Woodward del. et lith.

West, Newman imp.

CALYMENE, CHEIRURUS.

PLATE XIX.

FIG. PAGE.

Cheirurus (Sphærocoryphe) thomsoni, sp. nov. 146.

1. Nearly complete individual (head-shield laterally compressed). × 2. Starfish Bed, Thraive Glen. Mrs. Gray's Collection.
2. Pygidium, with last thoracic segment fused with it. × 2½. Same locality and Collection.
3. Ditto. × 2. Balclatchie. Same Collection.
4. Ditto. Imperfect. × 2½. Dow Hill. Same Collection.
5. Head-shield of variety? × 2. Balclatchie. Same Collection. (Figured by Nicholson and Etheridge, *op. cit.*, fasc. i, pl. viii, fig. 9, as *Staurocephalus ? unicus.*)
6. Left half of head-shield of same variety. × 2. Same locality and Collection.
7. Imperfect head-shield of same variety. × 2½. Same locality and Collection. (Figured by Nicholson and Etheridge, *op. cit.*, fasc. i, pl. viii, fig. 12, as *Stauro.* ? *unicus.*)

Cheirurus (Youngia) trispinosus, Young. 148.

8. Glabella and occipital segment. × 2½. Penkill. Mrs. Gray's Collection.
9. Ditto, with right cheek attached. × 2. Same locality and Collection.
10. Ditto, with nuchal spine. × 1½. Same locality and Collection.
11. Free cheek. × 2. Same locality and Collection.
12. Axial ring of thorax. × 2½. Same locality and Collection.

Cheirurus, sp. ind. (*a*). 149.

13. Hypostome. × 5. Dow Hill. Mrs. Gray's Collection.

Cheirurus, sp. ind. (*b*). 150.

14. Hypostome. × 5. Balclatchie. Mrs. Gray's Collection.

Cheirurus bimucronatus (Murchison). 138.

15. Pygidium. × 2. Woodland Point. Mrs. Gray's Collection.

Pliomera, sp. 153.

16. Pygidium. × 3. Auchensoul. Mrs. Gray's Collection.

Phacops (Pterygometopus) brongniarti, Portlock. 154.

17. Nearly complete individual. × 2. Dow Hill. Mrs. Gray's Collection.
18. Pygidium. × 2. Same locality and Collection.

Phacops (Phacopidella) elegans (Sars and Boeck). 154.

19. Head-shield. × 2. Bargany Pond Burn. Mrs. Gray's Collection.
20. Pygidium. × 3. Woodland Point. Same Collection.
21. Free cheek. × 2½. Newlands. Same Collection.
22. Head-shield. × 2½. Same locality and Collection.
23. Complete individual. × 4. Same locality and Collection.

G. M. Woodward del. et lith.

West, Newman imp.

CHEIRURUS, PLIOMERA, PHACOPS.

PLATE XX.

Fig. | Page.

Phacops (Chasmops) bisseti, sp. nov. 157.

1. Complete individual. × $1\frac{1}{2}$. Lady Burn. Mr. Bisset's Collection. (Pygidium foreshortened owing to curvature of body.)
1*a*. Side view of same specimen. × $1\frac{1}{2}$.
1*b*. Pygidium of same specimen. × 2.
2. Head-shield of same specimen from wax mould. × 2.
3. Head-shield of another specimen. × $2\frac{1}{2}$. Thraive Glen. Mrs. Gray's Collection.

Asaphus (Isotelus) instabilis, Reed. 162.

4. Free cheek. × $2\frac{1}{2}$. Dow Hill. Mrs. Gray's Collection.

Cyclopyge cf. **gigantea** (Barrande). 163.

5. Pygidium. × 3. Whitehouse Bay. Mrs. Gray's Collection.

Ampyx incurvus, sp. nov. 161.

6. Impression of side of head-shield, showing curved frontal spine. × 4. Dow Hill. Mrs. Gray's Collection.
7. Head-shield, showing the lateral scars on glabella. × $2\frac{1}{2}$. Ardmillan. Same Collection.
8. Ditto, with several thoracic segments attached. × 3. Dow Hill. Same Collection.

Illænus memorabilis, sp. nov. 165.

9. Middle portion of head-shield. × 2. Dow Hill. Mrs. Gray's Collection.

Illænus bowmani, Salter. 164.

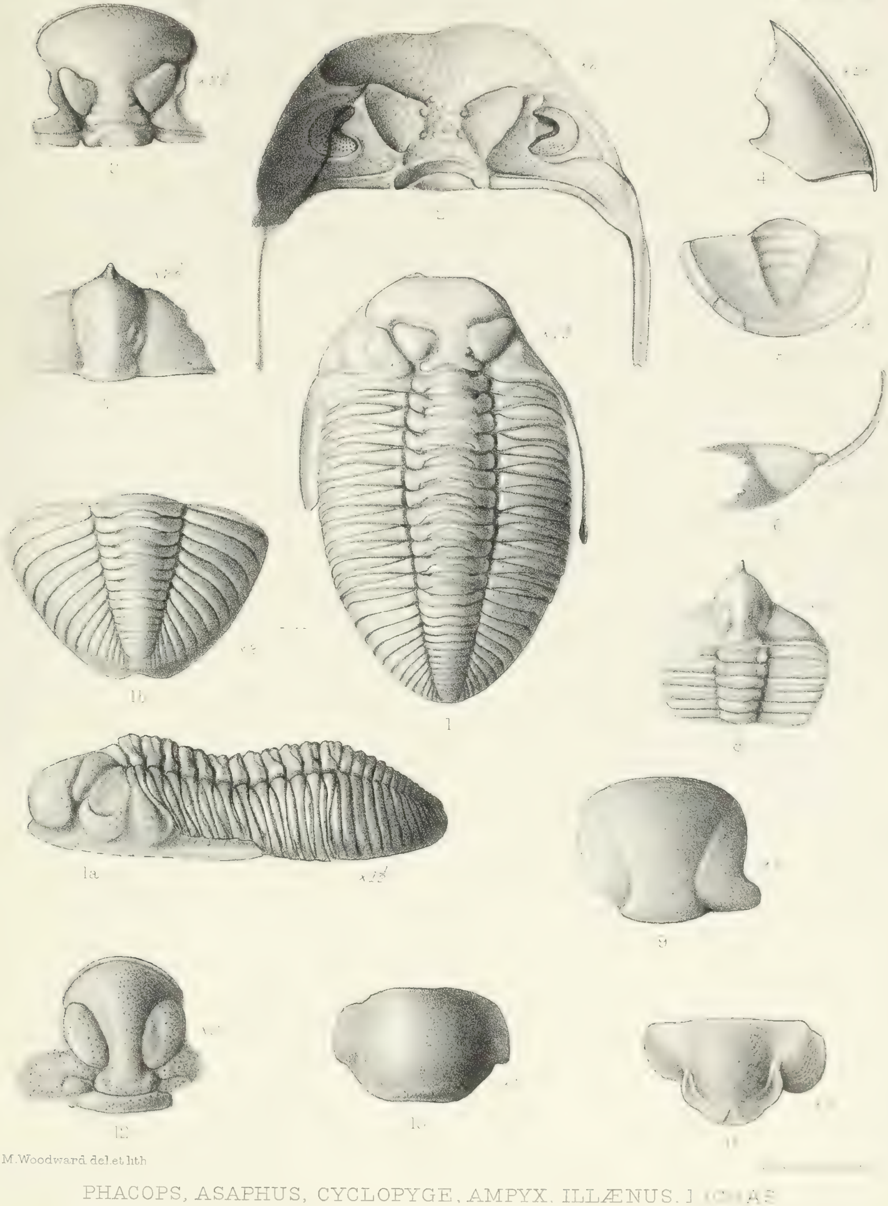
10. Hypostome attached to head-shield of complete individual. × 2. Starfish Bed, Thraive Glen. Mrs. Gray's Collection.

Illænus balclatchiensis, Reed ?. 163.

11. Hypostome. × 3. Balclatchie. Mrs. Gray's Collection.

Lichas (Platylichas) grayi, Fletcher, var. 167.

12. Head-shield. × $2\frac{1}{2}$. Mulloch Hill. Mrs. Gray's Collection.



G. M. Woodward del. et lith.

PHACOPS, ASAPHUS, CYCLOPYGE, AMPYX, ILLÆNUS, LICHAS

Palæontographical Society, 1906.

A MONOGRAPH

OF THE

BRITISH CAMBRIAN TRILOBITES.

BY

PHILIP LAKE, M.A., F.G.S.,
ST. JOHN'S COLLEGE, CAMBRIDGE.

PART I.

PAGES 1–28; PLATES I, II.

LONDON:
PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.
1906.

PRINTED BY ADLARD AND SON, LONDON AND DORKING.

THE BRITISH CAMBRIAN TRILOBITES.

INTRODUCTION.

The 'Monograph of British Trilobites,' which was begun by Salter in 1864, and the completion of which was interrupted by his death in 1869, includes descriptions of the families to which he assigned the names Phacopidæ, Cheiruridæ, Calymenidæ, and Asaphidæ. The forms with which he had dealt were, therefore, for the most part from the Ordovician and Silurian systems. The Carboniferous species were entirely untouched, and only one or two from the Cambrian and Devonian beds were described. Dr. Henry Woodward has since completed a Monograph of the Carboniferous Trilobites of Britain and Mr. Whidborne has described some of the Devonian species, but the Cambrian forms have received no further attention in the publications of the Palæontographical Society.

The long delay, however, has not been without its compensations. A monograph prepared in 1869 could have been no more than tentative, for at that time the rich material existing in the Cambrian of Scandinavia and Russia had been but imperfectly described and figured, and the specimens from our own beds are in many cases so extremely fragmentary and distorted that they could not of themselves furnish a firm foundation for the critical discrimination of species. It is on this account that so much confusion exists as to the meaning of the specific names which have been already employed in Britain.

In the following pages I have attempted, by means of a careful comparison with the much more perfect material available in Eastern Europe, to reduce our own species to order. But, as many of the Scandinavian forms are even now but poorly represented by published figures, I could hardly have attempted the task if I had not had the opportunity of examining the magnificent collections at Stockholm, St. Petersburg, and elsewhere. And I owe this opportunity to grants for the purpose from the Trustees of the Worts' Fund of the University of Cambridge and from the Government Grant Committee of the Royal Society, to whom, therefore, my thanks are in the first place due.

In the course of my investigations, which, though often interrupted by more

pressing duties, have now extended over a period of many years, I have received so much kindly assistance in the loan of specimens and in other ways that it would not be possible here to mention the names of all those who have helped me. But to Dr. Henry Woodward I am especially indebted for his continued encouragement in the study of a branch of science which he has made his own; and to Prof. T. McKenny Hughes for the facilities which he has afforded to me at Cambridge; while abroad my debt is greatest to one whom now I cannot thank, the late Prof. Lindström, of the Vetenskaps Akademi in Stockholm.

In the present instalment I am also particularly indebted to Mr. Frank Raw, B.Sc., of the University of Birmingham, for allowing me to quote his descriptions of *Agnostus dux* and *Agnostus callavei*, together with his notes on their affinities. Mr. Raw has made a special study of the Shineton Shale fauna, including these two forms, but his results have not yet been published.

Because of the imperfect condition of so many of our Cambrian fossils I have drawn special attention, wherever it seemed necessary, to those peculiar characteristics of each species which are least likely to be obscured in a poorly preserved specimen, and which at the same time serve to distinguish it from other forms with which it might be confused. These notes, which are added immediately after the formal description, will, I hope, prove useful to geologists who desire to identify species for stratigraphical purposes and who may have to depend entirely upon fragmentary and distorted specimens. It should, however, be borne in mind that species which are not closely allied to each other may possess a superficial resemblance which is likely to survive the effects of compression and distortion; and I am sometimes compelled to compare forms which really differ widely from one another, and which could not possibly be confounded if they were perfectly preserved.

SYSTEMATIC DESCRIPTIONS.

Family AGNOSTIDÆ.

Genus **AGNOSTUS**, Brongniart.

The genus *Agnostus* has been divided by Tullberg into four sections, which are characterised as follows:

(1) *Longifrontes.*—This group is distinguished by the prominent glabella and pygidial axis, which are usually fairly long. The test is either smooth, or the cheeks are furrowed, or the test both of cheeks and tail is ornamented with raised points. The margin is usually narrow. The cheeks in front of the glabella,

and the lateral lobes of the tail behind the axis are separated by an impressed line (in most species).

(2) *Lævigati.*—Distinguished by the fact that the lines which should define the glabella and the pygidial axis are effaced. Test always smooth and shining, sometimes with indications of furrows. The margin tends to vanish on the head, whereas on the tail it remains broad.

(3) *Limbati.*—This group is distinguished by the fact that the shields are in general more or less quadrate in form. The head has a broad margin. The basal lobes are large. The cheeks in front of the glabella are not separated by any groove, nor are they furrowed on the sides. The tail is commonly provided with spines.

(*a*) *Regii.*—Distinguished by its broad margin, the narrowness of the cheeks and of the lateral lobes of the tail, together with the breadth of the glabella (especially of the anterior lobe), and the shortness of the third segment of the pygidial axis.

(*b*) *Fallaces.*—In this section the head is narrower, the margin not so broad, the cheeks large, the basal lobes tolerably large, and the third segment of the pygidial axis is the longest.

(4) *Parvifrontes.*—This group is distinguished by its feebly developed glabella, which is not lobed.

Section Longifrontes.

1. **Agnostus fissus,** Lundgren MS. Plate I, figs. 1—3.

1879. *Agnostus fissus*, Linnarsson, Om faunan i kalken med Conocoryphe exsulans, Sver. geol. Unders., ser. C, no. 35, p. 23, pl. ii, fig. 34.

1880. *Agnostus fissus*, Tullberg, Om Agnostus-arterna, Sver. geol. Unders., ser. C, no. 42, p. 16, pl. i, fig. 3 *a—d*.

1896. *Agnostus fissus*, G. F. Matthew, Trans. N. Y. Acad. Sci., vol. xv, p. 230.

1896. *Agnostus fissus*, var. *trifissus*, G. F. Matthew, ibid., p. 231, pl. xvi, fig. 10.

1902. *Agnostus fissus*, var. *perrugata*, Grönwall, Bornholms Paradoxideslag, Danm. geol. Unders. II raekke, nr. 13, p. 50, pl. i, fig. 1.

Head rounded, with a narrow margin. Glabella bilobed; anterior lobe small, subquadrate, rounded in front, where it is cleft by an impressed furrow; posterior lobe slightly constricted a little in front of the middle, the anterior portion raised centrally into a slight keel, which bears towards its posterior extremity a small tubercle; basal lobes small, triangular. Cheeks nearly equal in width throughout, separated in front of the glabella by a slight furrow; surface ornamented by irregular furrows which are often radiate.

Thorax: axis raised on each side into a small knob, and the central portion also slightly raised; pleuræ of the anterior segment divided by a groove into a large anterior tubercle and a narrow posterior ridge; in the posterior segment the groove is more nearly central.

Tail rounded, with a narrow margin. Axis divided into three segments; the front segment is a little wider than the rest, is very short, and is tuberculate at its extremities; the middle segment is hexagonal and is raised medially into a longitudinal keel; the posterior segment is triangular, anteriorly it is about the same width as the middle segment, posteriorly it terminates in a blunt point. Lateral lobes of nearly equal width throughout and confluent behind the axis.

Head- and tail-shields, 3–3·5 mm. in length and breadth.

The only other British species yet known in which the anterior lobe of the glabella is cleft is *A. reticulatus*, which is at once distinguished by the reticulate markings on the cheeks.

The axis of the tail differs from that of most other allied forms in the fact that it is not constricted at the second segment, so that the second and third segments form a triangle with slightly convex sides. The line of demarcation between these two segments is sometimes very indistinct (as in fig. 1).

The species varies considerably in the character of the furrows which occur upon the cheeks and the lateral lobes of the tail. Sometimes these are rather faint and sometimes they are very strongly marked, and occasionally they may be seen on the glabella and the axis of the tail. Under the name *trifissus* Matthew has separated a variety which is characterised by the presence of "two additional furrows at the front of the glabella, one at each corner, beside the median furrow that characterises the type." Grönwall also separates another variety under the name *perrugata*, which is distinguished by two pairs of longitudinal furrows upon the cheeks.

In view of the great variation which is to be met with in the markings, these varieties seem to be of slight value, and the British specimens suggest that those furrows which are not radiate are sometimes the result of the crumpling of a test which was originally soft. This view seems to be supported by the not uncommon occurrence of longitudinal furrows on the glabella and the axis of the tail.

Horizon and Localities.—Menevian: near Nine Wells, St. David's; Dwrrhyd, near Solva.

2. **Agnostus punctuosus**, Angelin. Plate I, figs. 4—6.

1852. *Agnostus punctuosus*, Angelin, Pal. Scand., p. 8, pl. vi, fig. 11.
1875. *Agnostus punctuosus*, Brögger, Geol. För. Stock. Förh., vol. ii, p. 576, pl. xxv, fig. 2.
1879. *Agnostus punctuosus*, Brögger, Nyt Mag. for Naturv., vol. xxiv, p. 67, pl. vi, fig. 12 *a*, *b*.
1879. *Agnostus punctuosus* (var. *affinis*), Brögger, ibid., p. 68, pl. v, fig. 2 *a*, *b*.

1879. *Agnostus punctuosus* (var. *bipunctata*), Brögger, ibid., p. 68, pl. v, fig. 2 *c*.
1872. *Agnostus scutalis*, Salter (pars), Hicks, Quart. Journ. Geol. Soc., vol. xxviii, p. 175, pl. v, fig. 9 and perhaps fig. 10.
1872. *Agnostus scarabæoides*, Salter, Hicks, ibid., p. 175, pl. v, fig. 8.
1880. *Agnostus punctuosus*, Tullberg, Agnostus-arterna, p. 17, pl. i, fig. 5 *a*—*d*.
1896. *Agnostus punctuosus*, G. F. Matthew, Trans. N. Y. Acad. Sci., vol. xv, p. 232, pl. xvi, fig. 11 *a*, *b*

Head rounded, with narrow margin. Glabella nearly triangular, bilobed; the anterior lobe narrower than the posterior, triangular; posterior lobe large; basal lobes elongated, triangular. Cheeks separated in front of the glabella by a furrow (which is sometimes lost), surface granulate.

Tail rounded, with narrow margin. Axis formed of three segments; the anterior segment is wider but shorter than the others; the second narrower than the rest, hexagonal, longitudinally keeled, the keel forming a projection at its posterior extremity; the third segment forms an elongated isosceles triangle, with its point directed backwards and its basal angles slightly rounded. Lateral lobes granulate, united behind the axis, except in young specimens.

Head- and tail-shields 4–5 mm. long and wide.

The head of this species is easily distinguished from that of most other British forms by the triangular shape of the anterior lobe of the glabella and the scrobiculate surface of the cheeks. *A. pisiformis* possesses the former of these two characters, but its cheeks are smooth, the basal lobes are smaller, and the whole glabella is less nearly triangular in shape.

The tail is easily recognised, even in poor specimens, by the elegant shape of the axis, narrow at the second segment, immediately afterwards, at the base of the third segment, widening, and then tapering regularly to a rather sharp point. The axis of the tail of *A. exaratus* is somewhat similar in outline, but in that form there is no trace of segmentation, and the axial and marginal furrows and also the furrow behind the axis are all very deep.

Synonymy.—Agnostus scarabæoides, Salter, as described by Hicks, is clearly only a flattened and somewhat imperfect specimen of this species. In all the characters which it shows it agrees precisely with the Scandinavian form, excepting only that it is wider in proportion to its length, and this is apparently due to the flattening of a form which is most convex transversely. The original of Hicks's figure shows no furrow in front of the glabella, but this furrow is not always very distinct, even in the Swedish specimens of *A. punctuosus*, and might easily be obscured in a poorly preserved specimen.

The specimen figured by Hicks as the tail of *Agnostus scutalis* in 'Quart. Journ. Geol. Soc.,' vol. xxviii, pl. v, fig. 9, is a beautiful tail of *Agnostus punctuosus*—probably, from its small size and the presence of a furrow behind the axis, a young individual. The specimen shown in fig. 10 of the same plate is probably a still younger stage (cf. Tullberg, '*Agnostus*-arterna,' pl. i, fig. 5 *c*).

Types.—The originals of Hicks's *A. scarabæoides* and *A. scutalis*, figs. 9 and 10, are in the Sedgwick Museum, Cambridge.

Horizon and Localities.—Menevian : Porth-y-rhaw, St. David's ; Dolgelly.

3. **Agnostus davidis,** Salter. Plate I, fig. 7.

1866. *Agnostus davidis,* Salter, Brit. Assoc. Rep. for 1865, p. 285.
1872. *Agnostus davidis,* Hicks, Quart. Journ. Geol. Soc., vol. xxviii, p. 174, pl. v, figs. 2 and 4 (fig. 3 is doubtful).
1896. *Agnostus davidis,* Matthew, Trans. N. Y. Acad. Sci., vol. xv, p. 225, pl. xvi, fig. 6.

Head semicircular, with narrow margin. Glabella large, bilobed ; anterior lobe large, semicircular ; posterior lobe widens posteriorly, and is raised anteriorly into a large quadrate eminence constricted in the middle ; basal lobes large, elongated, triangular. The cheeks are wide posteriorly and contract forwards, and are separated in front of the glabella by a faintly impressed line ; surface rugose.

Thorax : axis broad, consisting of three raised portions, nearly equal in size ; pleuræ grooved, the groove in the first segment being near the posterior margin.

Tail nearly semicircular, with a fairly wide flat margin. Axis broad, showing the segmentation very imperfectly, but it appears to have been divided into three segments, the first wide but very short, the second probably hexagonal and slightly keeled, while the last is broken. Lateral lobes rugose. Margin widens posteriorly.

Head- and tail-shields 6—7 mm. long, 9—10 mm. wide.

This form is still very imperfectly known, and most of the specimens which have been referred to it in our museums belong to other species, including such diverse forms as *A. barrandei* and *A. fissus*. The most peculiar feature of Hicks's figured types (figs. 2 and 4) is undoubtedly the extraordinary elevation in the front portion of the posterior lobe of the glabella. The very large size of the species is remarkable, but the imperfect preservation of the types and the fact that no better specimens have yet been found which can be referred with certainty to the same species, unfortunately prevent me from instituting any satisfactory comparison with other forms. The characters of the tail in particular must still remain in doubt.

Types.—The originals of Hicks's figures 2 and 4 are in the Sedgwick Museum, Cambridge.

Horizon and Locality.—Menevian : Porth-y-rhaw, St. David's.

4. **Agnostus exaratus,** Grönwall. Plate I, figs. 8—10.

1866. *Agnostus scutalis,* Salter (pars), Brit. Assoc. Rep. for 1865, p. 285.
1872. *Agnostus scutalis,* Salter (pars), Hicks, Quart. Journ. Geol. Soc., vol. xxviii, p. 175, pl. v, figs. 12 and 13, and probably figs. 11 and 14 ; not figs. 9 and 10.
1902. *Agnostus exaratus,* Grönwall, Bornholms Paradoxideslag, p. 77, pl. i, fig. 17.

Head rounded, with narrow margin, axial and marginal furrows very deep. Glabella convex, bilobed ; anterior lobe large, subquadrate, rounded in front ; posterior lobe nearly parallel-sided, but slightly constricted in the middle, with a small median tubercle ; basal lobes very small. Cheeks smooth, somewhat convex, separated from each other by a deep furrow in front of the glabella.

Thorax : axis with a wide, central, raised portion and small lateral tubercles.

Tail rounded, widest posteriorly, somewhat longer than wide, axial and marginal furrows very deep, margin rather wide. Axis convex, shows no trace of segmentation, slightly constricted towards the anterior extremity, terminates in a long sharp point ; it bears a prominent median tubercle in the anterior third, and the posterior extremity is somewhat depressed. Lateral lobes smooth, convex, widen posteriorly, separated from each other by a deep furrow behind the axis. Margin rather wide, expanded posteriorly.

Head- and tail-shields about 5·5 mm. long, 5 mm. wide.

The most striking characteristic of this form is the depth of the axial and marginal furrows and of the groove behind the axis of the tail, and these characters are not possessed to anything like the same extent by any other British species. In compressed and distorted specimens, however, the strength of the furrows is not always so conspicuous ; but in these cases the large rounded lobe of the glabella and the rather long and very pointed unsegmented axis of the tail are generally sufficient to distinguish the species. The axis of *A. punctuosus* in its outline somewhat resembles that of *A. exaratus*, but the tail is easily distinguished by its segmentation and by the shallowness of the axial and other furrows, the absence of any furrow behind the axis (except a slight one in young forms), and by the fact that the lateral lobes diminish in width posteriorly instead of increasing. In perfect specimens there is not the slightest possibility of confounding the two.

Grönwall has described the tail only, but some of our specimens show the head and thoracic segments also.

Synonymy.—Salter's *Agnostus scutalis*, as described by Hicks, includes at least two distinct species. The description of the head corresponds fairly well with the head of the species now described ; but the description of the tail is apparently based on specimens of *A. punctuosus*. Hicks's fig. 9 is an imperfect representation of a beautifully preserved tail of a young *A. punctuosus* ; fig. 10 is possibly a still younger form of the same species (*cf.* Tullberg, '*Agnostus*-arterna,' pl. i, fig. 5 *c*) ; the original of fig. 12 is a rather poor specimen of the species under description ; and the originals of figs. 11, 13, and 14 are unfortunately not known. Fig. 13, however, is clearly a specimen of the species here described, and figs. 11 and 14 also probably belong to the same species. Several of the specimens in the Sedgwick Museum, labelled *Agnostus scutalis* by Salter, certainly belong to Grönwall's *Agnostus exaratus*. Owing to the confusion in the descriptions and figures of *A. scutalis*, it is clear that Salter's name cannot stand.

Types.—The original of Hicks's fig. 12 is in the Sedgwick Museum, Cambridge (also the originals of his figs. 9 and 10, which do not belong to this species).

Horizon and Localities.—Menevian: Porth-y-rhaw, St. David's; near Nine Wells, St. David's.

5. **Agnostus reticulatus,** Angelin. Plate I, fig. 11.

1852. *Agnostus reticulatus,* Angelin, Pal. Scand., p. 8, pl. vi, fig. 10.
1867. *Agnostus nodosus,* Belt, Geol. Mag., vol. iv, p. 295, pl. xii, fig. 3 *a* and *b*.
1880. *Agnostus reticulatus,* Tullberg, Agnostus-arterna, p. 23, pl. i, fig. 12 *a*, *b*.
1882. *Agnostus reticulatus,* Brögger, Die Silur. Etagen 2 und 3, p. 57, pl. i, fig. 11 *a*, *b*.

Head semi-elliptical, with narrow margin. Glabella narrow, bilobed; anterior lobe subquadrate, not very definitely marked off from the posterior lobe behind, nor always from the cheeks; frequently cleft in front by a deep furrow which extends forwards into the cheeks; posterior lobe elongate, raised into a prominent tubercle about the middle; basal lobes small, triangular. Cheeks wide, nearly uniform in width, marked by numerous reticulate furrows which show a tendency to a radial arrangement.

Tail semi-elliptical, with narrow margin, which bears a minute spine on each side. Axis long, narrow, divided into three segments; the first segment is short and divided into three nodules; the second is somewhat larger and is formed of a large central lobe, and two lateral lobes on each side; the third segment is long and pointed, and divided longitudinally into three portions; the central portion is divided transversely into a large anterior lobe, and a smaller posterior lobe; the lateral portions are each divided into a number (six according to Tullberg) of small tubercles. The lateral lobes are wide and marked with reticulate furrows.

Head- and tail-shields 3·5—5·5 mm. long and wide.

Among the British species the only form with which *A. reticulatus* is likely to be confused is *A. trisectus*, which resembles it closely in the ornamentation of the cheeks, so that although the two species are very distinct, yet when badly preserved they may be confounded with one another. The comparatively narrow glabella of *A. reticulatus*, its indistinct basal lobes, and somewhat ill-defined anterior lobe will, however, usually suffice to distinguish it; while in the tail the narrow and pointed axis will generally be visible even in imperfect specimens.

The British forms seem to be almost, if not quite, identical with those described by Tullberg from Scania. Tullberg, however, does not refer to the cleft in the anterior lobe of the glabella, and figures that lobe as much more distinctly defined than in our specimens. So far as the tail goes, there seems to be no difference, except that our specimens are seldom perfect enough to show the subdivisions of the axis, and sometimes only the central portion of the axis is at all distinct.

Brögger in his description states that the Christiania form does not agree precisely with Tullberg's figure and description, and in his figure the anterior lobe of the glabella is less distinctly defined than in Tullberg's.

Horizon and Localities.—Lower Lingula Flags : Tyn-y-groes and Cefn Deiddwr, Mawddach ; Dolgelly ; ? St. David's.

6. **Agnostus pisiformis** (L.). Plate I, fig. 12.

1757. *Entomolitus paradoxus γ pisiformis*, Linnæus, Iter. Scan., p. 122.
1821. *Entomostracites pisiformis*, Wahlenberg, Petr. Tel. Suec., p. 42, pl. i, fig. v.
1822. *Agnostus pisiformis*, Brongniart, Crust. foss., p. 38, pl. iv, fig. 4.
1827. *Battus pisiformis*, Dalman, Om Palæad., K. Vet. Akad. Handl. (1826), p. 258, pl. vi, fig. 5 *a—d*.
1837. *Battus pisiformis*, Hisinger, Leth. Suec., p. 19, pl. iv, fig. 5.
1837. *Battus pisiformis, β spiniger*, Hisinger, ibid., p. 20, pl. iv, fig. 6.
1852. *Agnostus pisiformis*, Angelin, Pal. Scand., p. 7, pl. vi, fig. 7.
1869. *Agnostus pisiformis*, Linnarsson, Om Vestergötlands Camb. och Sil. Aflagr., p. 81, pl. ii, figs. 50, 51.
1879. *Agnostus pisiformis*, Brögger, Nyt. Mag. for Naturv., vol. xxiv, pl. vi, fig. 13 *a, b*.
1880. *Agnostus pisiformis*, Tullberg, Agnostus-arterna, p. 25, pl. ii, fig. 14 *a, b*.
1882. *Agnostus pisiformis*, Brögger, Die Silur. Etagen 2 und 3, p. 55.
1895. *Agnostus pisiformis*, Wallerius, Zone med Agn. lævigatus, p. 43.

Although the typical form of this species appears to occur in Britain, the specimens are much distorted, and I therefore give Tullberg's description and a copy of his figure.

"Crusta lævis. Limbus non angustus. Caput rotundatum, latum. Frons non longa, biloba. Lobus anterior rotundatus. Lobus posterior supra medium puncto elevato ornatus, postice rotundatus. Lobi basales subtriangulares. Genæ ante frontem linea separatæ. Pygidium latum, rotundatum, bidentatum. Rachis lineolis vix visibilibus triarticulata, postice fere rotundata. Articulus medius postice puncto elevato præditus. Lobi laterales pone rachin non separati, postice angustati.

"Long. & lat. clypeorum, 5 mm."

6 *a*. **Agnostus pisiformis** (L.), var. **obesus,** Belt. Plate I, figs. 13, 14.

1867. *Agnostus pisiformis*, var. *obesus*, Belt, Geol. Mag., vol. iv, p. 295, pl. xii, fig. 4 *a—d*.
1880. *Agnostus pisiformis*, var. *socialis*, Tullberg, Agnostus-arterna, p. 25.
1882. *Agnostus pisiformis*, var. *socialis*, Brögger, Die Silur. Etagen 2 und 3, p. 56, pl. i, fig. 10 *a—c*.

Head rounded, with narrow margin. Glabella conical, bilobed ; anterior lobe small and narrow in front ; posterior lobe wider than the anterior lobe, widens

posteriorly, with a median tubercle, basal lobes small. Cheeks smooth, or sometimes with faint radiate markings, widest about the position of the anterior lobe, rather narrow in front of the glabella, where they are separated by a groove which is sometimes obsolete.

Thorax: axis divided into a central portion and two lateral knobs, all three approximately equal in size.

Tail rounded, with narrow margin, which in some specimens bears very small spines posteriorly. Axis wide, forming nearly half the width, and reaching nearly to the posterior margin. First segment represented by two lobes at the anterior corners; second segment hexagonal, the anterior angle separating the two lobes of the first segment, the posterior angle raised into a median tubercle; posterior segment large, rounded posteriorly, with parallel sides. Lateral lobes very narrow, especially posteriorly.

Head- and tail-shields up to 3·5 mm. in length and width.

This variety is easily distinguished from the typical *A. pisiformis* by the great width of the axis of the tail, and by the fact that the anterior segment of the axis is represented only by two lobes at the anterior corners of the axis. In this latter character and in the general form of the pygidial axis, the species approaches *A. rudis* and *A. sidenbladhi*, of which it appears to be the ancestral form. From both of these it is distinguished by the greater length of the glabella, while from the latter it is separated by the fact that the pygidial axis nearly reaches the posterior margin. The axis is also much more swollen than in any of the species mentioned.

Although Belt's figure is rather rough, there can be no doubt that it is the same form as that described by Tullberg under the name *socialis*.

Horizon and Localities.—Lower Lingula Flags: Maentwrog Falls; Mawddach Valley; Dolgelly; Trefgarn Bridge and Leweston Old Mills, Pembrokeshire; Chilvers Coton (Stockingford Shales). In some cases the horizon is given as Menevian, in others Upper Lingula Flags, but these determinations may be doubted.

7. **Agnostus trisectus,** Salter. Plate I, figs. 15, 16.

1864. *Agnostus trisectus*, Salter, Mem. Geol. Surv., Brit. Org. Remains, dec. xi, pt. i, p. 10, pl. i, fig. 11.

1864. *Agnostus princeps*, var. *a ornatus* (pars), Salter, ibid., p. 4, pl. i, figs. 4, 5.

1868. *Agnostus trisectus*, Belt, Geol. Mag., vol. v, p. 11.

1878. *Agnostus turneri*, Salter MS., Cat. Camb. & Sil. Foss. Mus. Pract. Geol., p. 12.

1880. *Agnostus trisectus*, Tullberg, Agnostus-arterna, p. 24, pl. i, fig. 13 *a, b*.

Head rounded, with narrow margin separated by a rather wide furrow.

Glabella large, wide, bilobed. Anterior lobe large, pentagonal, the base being at right angles to the axis, the sides parallel, while the front is formed by two lines which meet anteriorly at an angle of 90° or more; the posterior lobe impressed on each side a little in front of the middle, and raised centrally into a tubercle or keel; basal lobes large, forming each an elongated triangle, which reaches about halfway up the side of the posterior lobe. Cheeks separated by a deep groove in front of the glabella, nearly equal in width throughout except posteriorly, where they are encroached upon by the large basal lobes; marked by deep furrows which radiate outwards from the glabella to the margin, and are there interlined by other furrows which spring from the margin and extend inwards about halfway towards the glabella; in small, and presumably young, forms the furrows are much less strongly marked, and are sometimes almost obsolete.

Tail somewhat quadrate, with a wide margin which is produced on each side into a small point. Axis broad, divided into three segments, of which the first two are short and the second narrower than the others. A prominent keel runs through the first two segments, and terminates posteriorly in a prominent overhanging tubercle: in some specimens the keel seems to show traces of the furrow which separates the two segments; the third segment forms about two thirds of the axis, is widest near its anterior extremity, and terminates obtusely some distance in front of the margin; it is divided longitudinally into a median slightly raised portion, which is especially prominent anteriorly, and two lateral portions. Lateral lobes with a somewhat finely reticulate surface, confluent behind the axis, separated from the margin by a wide furrow.

Head- and tail-shields, 4—10 mm. long and wide.

In the ornamentation of its cheeks *A. trisectus* presents considerable resemblance to *A. reticulatus*, and it is quite possible that imperfect specimens of the one may be mistaken for the other, especially if only the head is present. The much greater width of the glabella, the large triangular basal lobes, together with the fact that the front lobe of the glabella is perfectly defined, will, however, generally suffice to distinguish even an imperfect specimen of *A. trisectus*. In the case of the tail there is very little difficulty, for in *A. trisectus* the width of the axis and the bluntness of its termination will usually be apparent even if the longitudinal division should not be visible.

The very numerous specimens from our various British localities generally have the anterior lobe of the glabella much more obtuse in front than is represented in Tullberg's figure; and, indeed, the more perfect specimens show it to be distinctly pentagonal in shape. In many cases also the lateral indentations of the posterior lobe are very distinctly marked, almost separating two lateral nodules on each side from the smooth central portion, much as Tullberg has described in the case of *A. reticulatus*. Lastly, in many of our English specimens the reticulation of the

surface of the cheeks and lateral lobes of the tail is much more distinct than in Tullberg's figure.

Synonymy.—Salter's *Agnostus princeps* was founded on specimens of three distinct species. His figs. 4 and 5 are from specimens of *A. trisectus*, fig. 1 from *A. pisiformis*, and fig. 3 from *A. rudis.*

In 1868 Belt (*loc. cit.*) recognised that the differences between *A. princeps* and *A. trisectus* were very small, and that it was often practically impossible to distinguish between the two, but he did not actually unite them because Salter was about to treat the genus in his 'Monograph.' Unfortunately, *Agnostus* is one of the genera which Salter did not live to complete.

Not infrequently in imperfect specimens the threefold longitudinal division of the last segment of the axis of the tail is barely visible, while the keel on the first two segments is still distinct, and this, perhaps, led Salter to conclude that he had two distinct species to deal with. The specimens which are called *A. princeps* in collections labelled by Salter are generally *A. trisectus*, occasionally *A. pisiformis.*

Types.—A sealing-wax cast of the original of Salter's fig. 11 is in the Geological Survey Museum, registered as 8768. The original of his *Agnostus princeps*, var. *ornatus*, fig. 4, is also in the same museum, registered as 8741.

Horizon and Localities.—Upper Lingula Flags: Carreg Wen, Borth; Moel Gron; near Craig-y-Dinas, Mawddach; Maentwrog; Yr Orsedd, Blaenau Ffestiniog; Penmorfa; Ogof-ddu, Criccieth; S.E. of Tryweryn; Malvern Hills.

Section LÆVIGATI.

8. **Agnostus altus,** Grönwall. Plate II, fig. 1.

1902. *Agnostus altus,* Grönwall, Bornholms Paradoxideslag, p. 58, pl. i, figs. 3, 4.

Head rounded, smooth, uniformly and slightly convex, surrounded by a narrow margin. Glabella obsolete, indicated only posteriorly by the basal lobes, which are small.

Thorax: axis faintly trilobed, pleuræ short and grooved.

Tail rounded, with narrow margin, gently convex. Axial furrows faintly marked. Axis wide, divided into three segments, which are separated by rather faint furrows. The first segment is wide and short; the second is narrower than the rest, hexagonal in shape, slightly raised along the median line into a slight keel which projects backwards over the posterior lobe; the posterior lobe is elongated and terminates in a rather blunt point. The lateral lobes are nearly uniform in width throughout and are confluent behind the axis.

Head- and tail-shields about 7 mm. long and wide.

The species with which this form is most likely to be confounded is *A. barrandei*. The head of the latter is distinguished by the presence of axial furrows which extend half the length of the head, while in *A. altus* only the basal lobes are present and the glabella is otherwise entirely obsolete. In imperfect specimens, however, this difference cannot always be discerned, as the axial furrows of *A. barrandei* may be obscured.

The axis of the tail in *A. barrandei* is surrounded by much stronger furrows than in *A. altus*, while on the other hand, the segmentation of the axis is much more distinct in *A. altus*, although even in this species it is not very strongly marked.

That this form belongs to Tullberg's section Lævigati can hardly be doubted; but it differs from most of the species of that group in having the pygidial axis completely defined by the axial furrows. In this respect it agrees with Brögger's *A. lævigatus* var. *forfex*[1] and Matthew's *A. lævigatus* var. *mamilla*[2] and var. *ciceroides*.[3] From the two former it differs in the complete segmentation of the axis, and from the last in its much greater size and in the fact that the second segment of the axis is perfectly defined posteriorly. Our specimens agree completely with Grönwall's *A. altus* except that, no doubt owing to compression, they are not so convex in shape. All the British specimens that I have seen are distorted by pressure.

Horizon and Localities.—Menevian: Porth-y-rhaw, St. David's; Waterfall Valley, near Maentwrog.

9. **Agnostus barrandei**, Salter. Plate II, fig. 2.

1872. *Agnostus barrandei*, Salter, Hicks, Quart. Journ. Geol. Soc., vol. xxviii, p. 176, pl. v, figs. 5, 6.
1902. *Agnostus lens*, Grönwall, Bornholms Paradoxideslag, p. 65, pl. i, figs. 8, 9.
1902. *Agnostus lens*, var. *frontosa*, Grönwall, ibid., p. 66, pl. i, fig. 10.

Head convex, rounded in outline, smooth or with minute tubercles, surrounded by a narrow margin. Glabella marked off posteriorly by two longitudinal furrows which extend for about half the total length of the head; but anteriorly there is no separation between the glabella and the cheeks; basal lobes small.

Thorax: axis formed of a central raised portion and two lateral tubercles; pleuræ deeply grooved.

Tail smooth or faintly tuberculate, rounded in outline, very convex, surrounded by a narrow margin. Axis separated from the lateral lobes by deep axial furrows, somewhat constricted at about a quarter of its length from the anterior margin,

[1] Brögger, Nyt Mag. for Naturv., vol. xxiv (1879), pl. v, fig. 6 *a*.
[2] G. F. Matthew, Trans. N. Y. Acad. Sci., vol. xv (1896), pl. xvii, fig. 2.
[3] G. F. Matthew, ibid., pl. xvii, fig. 3.

again widening out and finally terminating in a blunt point some distance in front of the margin; divided into three segments, but the dividing furrows are faint and frequently obsolete; there is a median tubercle on the middle segment. When visible, the anterior segment is very short; the middle segment narrow, hexagonal in shape, bearing a median tubercle at its posterior extremity; the posterior segment forms more than half the total length of the axis.

Head- and tail-shields up to 7 or 8 mm. long and wide.

Agnostus barrandei is distinguished from *A. altus* by the presence of axial furrows defining the glabella for about half the length of the head, by the much deeper axial furrows of the tail, and by the very vague and indistinct nature of the segmentation of the tail axis, which is indeed generally obsolete.

Types.—The originals of Hicks's figs. 5 and 6 are in the Sedgwick Museum, Cambridge.

Horizon and Localities.—Menevian: Rhaiadr ddu, near Maentwrog; Cwm hesian, Mawddach; Tyddyngwladys; Porth-y-rhaw and Penpleidiau, near St. David's.

10. **Agnostus rotundus,** Grönwall. Plate II, figs. 3, 4.

1902. *Agnostus rotundus*, Grönwall, Bornholms Paradoxideslag, p. 78, pl. i, fig. 19.

Head slightly convex, rounded in outline, with a rather narrow margin. The basal lobes are defined, but there is no other trace of the glabella.

Thorax: axis with a wide central portion and a small lateral nodule on each side, which is distinctly separated from the rest of the axis by a furrow which runs obliquely forward and inward. The pleuræ of the first segment are grooved by a furrow near the posterior margin.

Tail rounded in outline, not very convex. Axis rather wider than the lateral lobes, not segmented, widest near the front, with a small median tubercle at end of anterior third, decreasing rapidly and regularly backwards till it terminates in a blunt point. Lateral lobes widest in front, narrow slightly posteriorly, and confluent behind the axis, where they are narrowest. Axial and marginal furrows deep; the axis and lateral lobes are not in themselves gibbous, so that if the furrows were filled up the whole tail would be uniformly convex.

Head- and tail-shields about 3·5—4 mm. long and wide.

In some collections this species has been called *A. scutalis*, Salter, although it is not one of the various forms included by Salter under that name. It is easily distinguished from *A. exaratus* by the absence of the groove behind the axis of the tail, and by the much shallower axial furrows. The axis, moreover, is not constricted and the lateral lobes narrow posteriorly, while in *A. exaratus* they expand.

Grönwall has described and figured the tail only of this species, but thinks it not impossible that some of the heads which he has referred to *A. lundgreni* may really belong to *A. rotundus*. According to him the tail of *A. lundgreni* var. *nana* is the nearest to the tail of *A. rotundus*, but is nevertheless distinctly different. In *A. lundgreni* var. *nana*, it may be observed, the axis is distinctly segmented, and the lateral lobes are separated by a furrow behind the axis.

Our own specimens are so imperfect as regards the head that the description here given may well be incorrect. It seems, however, that even in perfect specimens the glabella cannot be very distinct.

Horizon and Locality.—Menevian: Porth-y-rhaw, St. David's.

11. **Agnostus nudus** (Beyrich). Plate II, fig. 5.

1845. *Battus nudus*, Beyrich, Ueber einige böhmische Trilobiten, p. 46, fig. 20.

1846. *Battus nudus*, Barrande, Notice préliminaire, p. 15.

1847. *Phalacroma nudum, P. emarginatum, P. carinatum, P. scutiforme, P. gibbosum,* Hawle and Corda, Prodrom., pp. 43–45, pl. iii, fig. 20.

1852. *Agnostus nudus*, Barrande, Système silurien, vol. i, p. 903, pl. xlix.

1879. *Agnostus nudus*, var. *marginata*, Brögger, Nyt Mag. for Naturv., vol. xxiv, p. 73, pl. vi, fig. 3.

1880. *Agnostus nudus*, var. *scanicus*, Tullberg, Agnostus-arterna, p. 29, pl. ii, fig. 18 *a, b*.

1880. *Agnostus nudus*, var. *marginatus*, Tullberg, ibid., p. 29, pl. ii, fig. 19 *a—d*.

1895. *Agnostus nudus*, Pompeckj, Jahrb. k. k. geol. Reichs., vol. xlv, p. 518, pl. xvi, figs. 7 *a, b, c*, 8 *a, b*.

Head smooth, forming rather more than half an ellipse, with a very narrow margin (invisible in the British specimens, owing no doubt to imperfect preservation), and without any trace of axial furrows.

Tail smooth, forming rather more than half an ellipse, with a broad margin, which is widest posteriorly and narrows rapidly towards the sides. The central portion, corresponding to the axis and lateral lobes of most Agnosti, is nearly circular in outline, is separated from the margin by a well-defined groove, and bears a small median tubercle near its front border. There is no trace of axial furrows.

Head- and tail-shields about 4·5 mm. long, 4 mm. wide (in a somewhat distorted specimen).

I have seen only one British specimen which can be referred with certainty to this species, and it appears to belong to the form which has been distinguished by Brögger as *A. nudus* var. *marginatus*.

A. barlowi and *A. eskriggei* are the only British species with which it is likely to be confounded. In both these forms the base of the glabella is defined by two very short axial furrows, and in *A. barlowi* the axis of the tail is similarly indicated. In *A. nudus*, on the other hand, there is no trace of differentiation of the axis on

either head or tail. *A. eskriggei* is very similar to some of the young forms of *A. nudus* described by Barrande.

Horizon and Locality.—Menevian: Dolgelly. A badly-preserved tail which looks like *A. nudus* var. *scanicus*, Tull., has been found in the Stockingford Shales, Stockingford cutting, near Nuneaton, and is now in Prof. Lapworth's collection; but a somewhat similar tail from the same locality seems to show traces of an axis. In view of their imperfect preservation I hesitate to refer them to this species.

12. **Agnostus eskriggei,** Hicks. Plate II, fig. 6.

1872. *Agnostus eskriggei,* Hicks, Quart. Journ. Geol. Soc., vol. xxviii, p. 175, pl. v, fig. 7.

Head smooth, very convex, forming a large segment of a circle; no trace of a margin visible. Glabella marked only by two very short axial furrows at its base.

Thorax: axis rather narrow, with a nodule on each side.

Tail smooth, very convex, forming a large segment of a circle. There is a central portion separated from the rest by a deep furrow, and this is almost circular in shape. The portion outside the circular furrow is nearly uniform in width throughout.

Head 1·7 mm. long, 2·1 mm. wide; tail 1·6 mm. long, 2·5 mm. wide.

This species, of which only one specimen is known, resembles *A. nudus* (Beyrich), and is possibly only a young form. In *A. nudus*, however, it is clear that the central portion of the tail corresponds with both the axis and the lateral lobes of an ordinary *Agnostus*, while in *A. eskriggei* it seems possible, though not probable, that the central portion may represent the axis, and the surrounding part the lateral lobes. If this should prove to be the case the resemblance to *A. nudus* must be superficial, and there is no known species with which *A. eskriggei* can be compared. The general appearance of the species is decidedly different from that of a full-grown *A. nudus*, but is much closer to that of some of the young forms figured by Barrande. These, however, do not show the short axial furrows at the base of the glabella.

Type.—Hicks's original is in the Sedgwick Museum, Cambridge.

Horizon and Locality.—Menevian: Porth-y-rhaw, St. David's.

13. **Agnostus barlowi,** Belt. Plate II, fig. 7.

1868. *Agnostus barlowii,* Belt, Geol. Mag., vol. v, p. 11, pl. ii, figs. 17, 18.
1880. *Agnostus cicer,* Tullberg, Agnostus-arterna, p. 26, pl. ii, fig. 16 *a, b.*[1]

[1] This figure, as Tullberg notes, is inverted, and the tail is placed above the head.

Head semi-elliptical, convex, smooth, with very narrow margin. Glabella obsolete, except posteriorly, where it is barely indicated by a faint line. There is a small median tubercle about one third the length of the head from the neck furrow. Basal lobes indistinctly indicated.

Thorax: axis wide, with a wide central portion and small lateral knobs.

Tail: semi-elliptical, convex, smooth, surrounded by a wide (flat?) margin, which is of equal width throughout. Axis wide, indicated by two short furrows in front, but obsolete posteriorly. A prominent median tubercle near anterior margin.

Head- and tail-shields 3·5—4 mm. long, 3—3·5 mm. wide.

Perfect specimens are not likely to be mistaken for any other form, but the head by itself might possibly be taken for the head of *A. altus*. The latter, however, is much larger, and it is completely surrounded by a narrow margin. In *A. barlowi* the margin, when preserved, seems to be confined to the posterior portion of the head.

Belt's figure and description leave no doubt that his species is the same as that described by Tullberg under the name *A. cicer*. Fortunately, also, in the Belt collection in the British Museum there is a specimen, probably the original of Belt's figure, with the label *Agnostus barlowii*.

Agnostus cicer is recorded by Tullberg from the *Conocoryphe æqualis* zone and from the *Agnostus intermedius* zone, both of which belong to the *Paradoxides* beds. Belt, on the other hand, states that *Agnostus barlowii* comes from the Tremadoc, and is associated with *Asaphus innotatus*. As the occurrence of the species in the *Paradoxides* beds is indubitable, it seems probable that this is one of the very few mistakes in Belt's paper on the Lingula Flags.

Type.—The specimen registered as 58498 in the British Museum (Natural History) is probably the original of Belt's fig. 18.

Horizon and Locality.—Probably Menevian: Upper Mawddach.

Section LIMBATI.

(*a*) *Regii.*

14. **Agnostus cambrensis,** Hicks. Plate II, figs. 8, 9.

1871. *Agnostus cambrensis*, Hicks, Quart. Journ. Geol. Soc., vol. xxvii, p. 400, pl. xvi, figs. 11, 12.
Non 1872. *Agnostus cambrensis*, Hicks, ibid., vol. xxviii, pl. v, fig. 1.

Head somewhat quadrate, with a broad margin, which is separated from the cheeks by a broad furrow. Glabella bilobed; the anterior lobe is expanded, nearly semicircular in shape, and highly convex; the posterior lobe is somewhat narrower

and nearly cylindrical, and bears a small tubercle at its base; basal lobes not seen. Cheeks steeply inclined downwards from the glabella, greatly contracted forwards and reduced in front of the glabella to a narrow strip. The marginal furrow is narrow posteriorly and widens greatly towards the front.

Tail subquadrate, with a wide margin which is nearly uniform in width. Axis forms about half the width of the whole tail, is slightly constricted in front of the middle, and terminates bluntly in a rounded obtuse angle. It bears a prominent median tubercle or elevation and is marked on each side by three lateral furrows, of which only the first pair meet in the centre. Axial furrows deep. Lateral lobes greatly narrowed behind the axis, where they are confluent with each other.

Head 2·5—4 mm. long, 3·5—4·5 mm. wide; tail 3 mm. long, 5 mm. wide. The specimens are somewhat distorted.

This form belongs to Tullberg's series *Regii*. The head, indeed, is scarcely to be distinguished from that of *Agnostus rex*, Barrande,[1] itself, but the axis of the tail does not show the terminal expansion so characteristic of that form. In this respect it agrees with *A. regulus*, Matthew,[2] with which indeed it may prove to be identical. *A. regius*, Sjögren,[3] is another closely allied form, the tail of which, however, is nearer to that of *A. rex* than to that of either *A. cambrensis* or *A. regulus*.

Synonymy.—The form here described is that which was originally figured and described by Hicks under this name. Subsequently, in 1872, he figured another form under the same name; but this is clearly distinct and is identical with *A. integer* (Beyr).

Types.—The originals of Hicks's figs. 11 and 12 are in the Sedgwick Museum, Cambridge.

Horizon and Locality.—Harlech Series: St. David's.

(*b*) *Fallaces.*

15. **Agnostus integer** (Beyrich). Plate II, fig. 10.

1845. *Battus integer*, Beyrich, Ueber einige böhmische Trilobiten, p. 44, fig. 19.
1846. *Battus integer, B. orion, B. affinis, B. cuneifer*, pars, Barrande, Notice préliminaire, pp. 14—18.
1847. *Mesospheniscus cuneifer, Diplorrhina rotundata, D. triplicata, D. orion, D. umbonata, D. sirius, D. elliptica, D. asperula, D. selenophora, D. monas, D. affinis, D. cristata, Peronopsis integra*, Hawle and Corda, Prodrom., pp. 46—50, 115, pl. iii, figs. 22, 23, pl. vi, fig. 62.
1852. *Agnostus integer*, Barrande, Système silurien, vol. i, p. 900, pl. xlix.

[1] Barrande, Syst. Silur., vol. i, p. 908, pl. xlix.

[2] G. F. Matthew, Trans. N. Y. Acad. Sci., vol. xv (1896), p. 213, pl. xvi, fig. 1.

[3] Sjögren, Geol. För. Stockh. Förh., vol. i (1872), p. 76, pl. v, fig. 6. See also Linnarsson, ibid., vol. iii, pl. xv, figs. 9, 10.

1872. *Agnostus cambrensis*, Hicks, Quart. Journ. Geol. Soc., vol. xxviii, pl. v, fig. 1. (Not Hicks, Quart. Journ. Geol. Soc., vol. xxvii (1871), p. 400, pl. xvi, figs. 11 and 12.)
1895. *Agnostus integer*, Pompeckj, Jahrb. k. k. geol. Reichs., vol. xlv, p. 521.
1895. *Agnostus integer*, var. *spinosa*, Pompeckj, ibid., p. 522, pl. xvi, fig. 6 *a*, *b*.

Head subquadrate, somewhat longer than broad, with a narrow margin. Glabella bilobed, anterior lobe small, broad, rounded in front; posterior lobe somewhat wider than the anterior lobe, slightly constricted in the middle, with a small median tubercle; basal lobes small. Cheeks nearly equal in width throughout, confluent in front of the glabella, rugose, marked by irregular furrows.

Thorax: lateral nodules of axis nearly as large as the central portion.

Tail quadrate, with a broad margin which widens greatly posteriorly, and is produced into a very short spine at each side. Axis wide, somewhat contracted at about one third of its length from the anterior margin; divided by two furrows on each side, which do not quite reach the middle; with a median keel; terminates in a blunt point which does not quite reach the posterior margin. Lateral lobes narrow, reduced behind the axis, where the two lobes unite, to a mere strip. The margin is narrow in front, widens posteriorly, and is produced into two very short lateral spines.

Head- and tail-shields about 3—4 mm. long and wide.

A. integer presents some resemblance to *A. fallax*, Linrsn.; but in *A. fallax* the glabella is smaller and the posterior lobe is little, if at all, wider than the anterior lobe; the axis of the tail is shorter and the divisions upon it are less distinct. *A. fallax*, moreover, appears to be smooth and without the rugosities characteristic of *A. integer*, and the margin of the head is wider than in the latter species.

Both Beyrich and Corda represent the tail of this species with lateral spines, but Barrande asserts that these do not exist. Pompeckj states that many of the specimens are not spined and that the tail is merely sharply angular, but in some examples from "Pod hruškou," near Tejřovic, and also in some from Jinec, he finds that the angles are produced into short teeth, and to this form he gives the name of var. *spinosa*. Pompeckj's figure also agrees with the Welsh specimen in the fact that the axis does not quite reach the margin of the tail.

Synonymy.—The specimen here described is that which was figured by Hicks in 1872 as *Agnostus cambrensis*, but it is quite different from the form which he had already described under that name in 1871, and which belongs to the group of *Agnostus rex*. The resemblance to *Agnostus integer*, as described and figured by Barrande, is complete, except for the fact that the margin of the tail bears short spines and that the axis does not quite reach to the posterior margin. In the latter respect the specimen agrees with the younger forms figured by Barrande.

Types.—The original of Hicks's figure of "*A. cambrensis*" in 'Quart. Journ. Geol. Soc.,' vol. xxviii, pl. v, fig. 1, is in the Sedgwick Museum.

Horizon and Locality.—Menevian: Porth-y-rhaw, St. David's.

16. **Agnostus securiger**, sp. nov. Plate II, fig. 11.

This remarkable form, for the loan of which I am indebted to Prof. Lapworth, is closely allied to *A. integer*, and may indeed be no more that a deformed specimen of that species.

It is rather larger than is usual in *A. integer*, but the head appears to show no other difference.

The most striking peculiarity is that the axis of the tail expands posteriorly into a hatchet-shaped termination which occupies the whole of the posterior half of the tail, exclusive of the margin. The lateral lobes are accordingly restricted to a narrow space on each side of the axis in the front portion of the tail only; and each lateral lobe is marked by a median longitudinal furrow for about half of its length.

The specimen, however, is not perfect, and it is difficult to be certain that these characters are not due to the mode of preservation.

Head- and tail-shields, 5 mm. long, 5·5 mm. wide.

Horizon and Locality.—(? Menevian): Chapel End, near Nuneaton, "40 feet below unconformity." (Collected by Mr. Sykes.)

17. **Agnostus fallax**, Linnarsson. Plate II, fig. 12.

1869. *Agnostus fallax*, Linnarsson, Om Vestergötlands Cambriska och Siluriska aflagringar, Kong. Svensk. Vet. Akad. Handl., n. s., vol. viii, no. 2, p. 81, pl. ii, figs. 54, 55.

1877. *Agnostus fallax*, Linnarsson, Geol. För. Stockh. Förh., vol. iii, p. 371, pl. xv, fig. 7.

1879. *Agnostus fallax*, Brögger, Nyt. Mag. for Naturv., vol. xxiv, p. 64, pl. vi, fig. 1.

1879. *Agnostus fallax*, Linnarsson, Om faunan i kalken med Conocoryphe exsulans, p. 22, pl. ii, fig. 33.

1880. *Agnostus fallax*, Tullberg, Om Agnostus-arterna, p. 31, pl. ii, fig. 22 (forma *typica*), fig. 23 *a*, *b* (forma *ferox*).

1896. *Agnostus fallax*, G. F. Matthew, Trans. N. Y. Acad. Sci., vol. xv, p. 214.

1902. *Agnostus fallax*, Grönwall, Bornholms Paradoxideslag, p. 68.

Head subquadrate, with a wide margin. Glabella bilobed, anterior lobe broad, rounded in front; posterior lobe nearly parallel-sided, but slightly indented on each side in front of the middle, with a small median tubercle; basal lobes large, triangular. Axial furrows fairly deep. Cheeks confluent in front of the glabella, widening slightly posteriorly.

Head-shield 4 mm. long and wide.

The width of the margin, the rounded anterior lobe of the glabella, and the large basal lobes are sufficient to distinguish this form from any other British species yet known. The head of *A. exaratus* is probably the form which is most likely to be

confused with it so far as the head is concerned; but in this the basal lobes are small and the margin is narrow.

Of this form very few specimens seem to have been found in Great Britain, and these are mostly heads. In the absence of tails it is difficult to identify the species with certainty; for other forms, such as *A. kjerulfi*, are barely distinguishable from *A. fallax* except by the characters of their tail. In Brögger's figure of *A. kjerulfi*, however, the marginal fold of the head is narrower than in *A. fallax*, and in this respect the British specimens which I have seen agree more nearly with the latter.

Horizon and Locality.—Menevian: Porth-y-rhaw, St. David's.

18. **Agnostus rudis,** Salter. Plate II, figs. 13—16.

1864. *Agnostus princeps*, var. *rudis* (pars), Salter, Brit. Org. Rem., dec. xi, pt. i, p. 4, pl. i, fig. 3 (only).

Head moderately convex, rounded, with narrow margin which is produced into a short spine at the genal angles. Glabella bilobed; anterior lobe rather small, rounded in front; posterior lobe nearly parallel-sided; basal lobes small. Cheeks smooth, nearly equal in width throughout, confluent with one another in front of the glabella.

Tail rounded in its general outline, with rather wide margin, which is produced posteriorly into two very small spines. Axis long and rather wide, parallel-sided, rounded posteriorly; anterior segment represented by two small lobes cut off at each anterior corner; the second segment extends forwards between these two lobes and posteriorly bears a prominent tubercle; the posterior segment forms nearly two thirds of the axis, is smooth and rounded posteriorly. Lateral lobes very narrow behind axis, where they are confluent with one another.

Head- and tail-shields, 2—3·5 mm. long and broad.

This form is nearly allied to *A. dux* and *A. sidenbladhi.* From the former it is at once distinguished by the much greater length of the axis of the tail. *A. sidenbladhi* also has a shorter pygidial axis, and the anterior lobe of the glabella is larger, but less distinctly defined.

In some respects *A. rudis* resembles *A. pisiformis*, and may indeed be looked upon as intermediate between that species and *A. dux.* But in *A. pisiformis* the cheeks are separated by a groove in front of the glabella, while the front lobe of the tail-axis is complete across. In *A. pisiformis*, var. *obesus*, the first segment of the tail-axis is represented by two small lobes at the anterior corners as in *A. rudis*, but the axis is much more swollen and the glabella is much longer.

It may be remarked that in front of the glabella, even in the actual specimens on which Salter's figure is founded, there is usually no trace of the groove which he shows. One specimen, indeed, shows such a groove, but it may possibly be a young *A. trisectus*, as it differs also in other characters.

Synonymy.—This is one of the forms which was described and figured by Salter as *Agnostus princeps*, a species which he divided into two varieties, var. *ornatus* and var. *rudis*. The specimens which he ascribed to the former variety belong to his species *A. trisectus*, while in var. *rudis* he included distorted specimens of *A. pisiformis* from the Lower Lingula Flags, and specimens of the present species from the Upper Lingula Flags. As *A. pisiformis* and *A. trisectus* are already provided for, it might have been possible to restrict the name *A. princeps* to the form here described. But, unfortunately, by far the greater number of specimens which have been identified as *A. princeps* by Salter and others, belong either to *A. pisiformis* or to *A. trisectus*; and therefore, to avoid confusion, it seems better to drop that name altogether and to employ the alternative *rudis*, although this name is by no means descriptive.

Type.—The original specimens on which Salter's fig. 3 is founded are in the Geological Survey Museum (registered as nos. 8723—8728). It is, however, impossible to say exactly which of these specimens was used. The figure appears to be composite.

Horizon and Localities.—Upper Lingula Flags: Penmorfa; Ogofddu, near Criccieth, with *A. trisectus* (collected by Mr. W. G. Fearnsides).

19. **Agnostus sidenbladhi,** Linnarsson. Plate II, fig. 17.

1869. *Agnostus sidenbladhi,* Linnarsson, Om Vestergötlands Camb. och Sil. Aflagr., p. 82, pl. ii, figs 60, 61.

Head quadrate, with a broad margin, which is widest at the anterior angles but narrows considerably towards the genal angles. Glabella about two thirds the length of the head and one third the width, nearly parallel-sided, rounded in front; the anterior lobe is very indistinctly marked off from the posterior by a very faint furrow; the posterior lobe forms about two thirds of the whole length; basal lobes small. Cheeks nearly equal in width throughout, confluent in front of the glabella.

Thorax: axis wide, lateral nodules small, and not very clearly marked off from the central portion; pleuræ grooved.

Tail quadrate, with a wide margin, which is produced at the posterior angles into a short point. Axis short, with nearly parallel sides, rounded behind; anterior segment reduced to two small lobes at the anterior angles; middle segment also very short, produced forwards between the two lobes which represent the anterior segment, bears a median keel or tubercle, which is most prominent at its posterior extremity. The third segment forms about two thirds of the whole axis. Lateral lobes uniform in width throughout, confluent behind the axis.

Head- and tail-shields, about 2·5 mm. long and wide.

There can, I think, be little doubt that this form belongs to Linnarsson's species. The head agrees very closely with Linnarsson's figure. The tail differs in the extreme shortness of the first two segments, which is, however, in part due to compression. In Linnarsson's figure, moreover, the median tubercle runs through the anterior and middle segments of the axis, and is clearly separated from both. In our specimen the keel is distinctly a part of the middle segment, and projects forwards between the lobes into which it divides the anterior segment. So far, indeed, as the tail is concerned, Linnarsson's figure is much nearer to the following species, but the head is very different. From the evidence afforded by our British specimens one would be disposed to infer that the head and tail of Linnarsson's figure belong to different species.

A. sidenbladhi is closely allied to *A. rudis* and to *A. callavei*; it is somewhat less closely connected with *A. dux*; and in the structure of its tail-axis it even shows affinities with the Lower Lingula Flag form *A. pisiformis* var. *obesus*. From *A. rudis* it is distinguished by its much shorter tail-axis, and by the extreme faintness of the furrow which separates the anterior from the posterior lobe of glabella. From *A. dux* it is separated by the considerably greater length of its glabella and of the axis of the tail. Its closest ally is undoubtedly *A. callavei*, F. Raw, which, in spite of the difference in size, it resembles very closely in the proportions of its parts. If, however, the remarkable diverging furrows in that form, which separate the anterior lobe of the glabella from the posterior lobe, are not adventitious markings, this alone is a sufficient distinguishing feature. In *A. callavei*, moreover, there is a strong tubercle or ridge on the posterior lobe of the glabella. This is reduced in *A. sidenbladhi* to an almost indistinguishable prominence.

Horizon and Locality.—Tremadoc: Penmorfa (collected by Mr. W. G. Fearnsides).

20. **Agnostus calvus,** sp. nov. Plate II, fig. 18.

This form is closely allied to the preceding, but occurs at a slightly lower horizon. It differs chiefly in the following points. The glabella is somewhat narrower and the anterior is distinctly separated from the posterior lobe. The axis of the tail is longer, and the first two segments are proportionately much better developed; the anterior and second segments, which are nearly equal in length, are both divided into three parts by longitudinal furrows, the central portion being raised so as to form an elongated tubercle, on which the division between the two segments is still visible; the posterior segment forms about half of the whole axis.

Head- and tail-shields, 3 mm. long and wide.

The tail of this species appears to be identical with that figured by Linnarsson as the tail of *A. sidenbladhi*, but the head is decidedly different. Mr. W. G. Fearnsides, who found the specimens figured on Plate II as *A. calvus* and *A. sidenbladhi*, informs me that the former occurs at the base of the *Asaphellus* flags and the latter at the top. In Scandinavia the thickness of the deposits is much reduced and the two should occur within a few feet of each other.

Horizon and Locality.—Tremadoc: base of *Asaphellus* flags near Nant rhos ddu, Arenig.

21. **Agnostus dux,** Callaway. Plate II, fig. 19.

1877. *Agnostus dux,* Callaway, Quart. Journ. Geol. Soc., vol. xxxiii, p. 665, pl. xxiv, fig. 3.

For the following description and notes on the affinities of this species I am indebted to Mr. Frank Raw of the University of Birmingham, who has made a special study of the Shineton Shale fauna.

"Head roughly circular in outline, somewhat quadrate, widest in front of the centre, narrowing slightly posteriorly, genal angles obtusely pointed. Marginal rim almost flat round the front half of the shield, broadest at the anterior corners. Cheeks smooth, convex, nearly uniform in width round the front of the axis. Glabella about half the length of the head and one third its width at the back, narrowing in front; rounded in front and behind, convex, bilobed, the anterior lobe occupying about one third of the length; basal lobes very small, lateral.

"Thorax: central division of the axis wide, being equal in the anterior segment to the articulating knob together with the pleura on each side; narrower in the posterior segment; pleuræ curved forwards, posterior lateral edges semicircular; posterior longer than the anterior pleuræ.

"Tail a quadrilateral oval, of the same width as the head, but somewhat shorter, lateral margins continued into short spines; limb large, wider behind, with a fairly flat margin and a shallow depression running round the limb at one third the width from its edge. Axis wider than that of the head but somewhat shorter, rounded behind, slightly broadening in front; anterior segment widening into a lobe on each side, second segment extending forwards between these but not reaching the anterior border, bounded behind by a faint transverse furrow, and bearing a blunt longitudinal tubercle rising in height to the back of the segment; posterior segment a little more than half the length of the axis.

"Dimensions of Callaway's type specimen, the largest seen by the writer: Total length, 8 mm.; head, length 3·8 mm., breadth 4·1 mm.; tail, length 3·5 mm., breadth 4·1 mm.

"*Affinities.*—Brögger[1] compares *A. dux* with *A. sidenbladhi*, which occurs

[1] Die Silur. Etagen 2 und 3, p. 144.

on a somewhat higher horizon in Sweden. It agrees with this throughout in its general character, but is widely different in its proportions. *A. dux* is broader throughout, and the head- and tail-shields are rounded laterally; its axes, both of head and tail, are much shorter; its marginal furrow is much shallower and farther from the margin; the furrow across the glabella is nearer the front; the anterior furrow across the tail-axis is arched, not straight; and the tail-spines are not directed outwards as in *A. sidenbladhi*.

"*A. dux* closely resembles Angelin's figure of *A. lentiformis*,[1] Ang., in general shape, differing chiefly in its shorter axes and the presence of the glabellar furrow and tail-spines. It is also similarly close to his allied form *A. glabratus*, Ang.,[2] and still more so to that figured under *A. glabratus* var. *ingrica* by F. Schmidt,[3] from which it differs in that both its head and tail narrow towards the thorax, and both are more rounded, while the glabellar furrow is stronger and farther forward.

"The head of *A. dux* agrees exactly with the description of *A. bavaricus*, Barr.,[4] which comes from the same or nearly the same horizon, with the exception that *A. dux* is much broader in proportion. Its relations with the new species *A. callavei*, found associated with it in Shineton Brook, are noticed under that form.

"*Type*.—The original of Callaway's figure is in the Museum of Birmingham University. The external cast of this specimen is in the Sedgwick Museum, Cambridge.

"*Horizon and Localities*.—Tremadoc: several specimens having been found in the Shineton Shales at Shineton by Dr. Callaway and by Mr. R. Rhodes for the Geological Survey at 18—20 chains S.W. of Shineton Church. It is also recorded by Prof. T. Groom from the grey shales of the southern Malverns."

22. **Agnostus callavei,** F. Raw, MS. Plate II, fig. 20.

For the following description and notes on this species I am again indebted to Mr. Frank Raw.

"Head roughly circular in outline, but broader than long; marginal furrow very shallow, genal angles rounded. Cheeks smooth, convex, narrower round the front of the glabella. Glabella two thirds the length of the head-shield and one third the width, well defined by sub-parallel axial furrows, round in front, widening behind, with the posterior angles cut off by oblique narrow grooves; bearing an

[1] Pal. Scand., p. 7, pl. vi, fig. 6. See also Wiman, Arkiv. f. Zool., vol. ii, no. 11 (1905), pl. i, figs. 21, 22.

[2] Angelin, *op. cit.*, p. 6, pl. vi, fig. 5. Wiman, *loc. cit.*, pl. i, figs. 27, 28.

[3] Revision d. Ost-Baltischen Trilobiten, pt. iv. (1894), p. 90, pl. vi, figs. 39—44. See also Wiman, *loc. cit.*, pl. i, figs. 23, 24.

[4] Faune silurienne des environs de Hof, en Bavière, p. 82, fig. 46.

elongated tubercle, which extends a quarter of the length of the glabella, and is equidistant from its two ends; from the sides of this tubercle in front two narrow grooves[1] curve forwards and outwards, approximately at right angles to one another, as far as the axial furrows.

"Thorax rather deep; central division of the axis, in the posterior segment, equal in width to the articulating bosses on either side, larger in the anterior segment; pleuræ curved forwards, posterior edges semicircular, posterior longer than the anterior pleuræ.

"Tail a little shorter than the head, which it closely resembles except in the possession of spines and the different furrows on the axis; lateral margins in some specimens curved, in others straight, passing back into spines which curve inwards; posterior margin well rounded; limb a little narrower than the axis, and a little narrower behind than at the sides. Axis more than two thirds the length of the shield, rounded behind, slightly narrowed in front of the centre, broadening in front; anterior segment represented by two lobes at the anterior corners; second segment extending forwards between these, almost to the anterior margin, at the sides somewhat longer than the anterior segment, bearing a median longitudinal tubercle which is highest near the back of the segment, whence it extends forwards over the segment and backwards into the posterior segment, dying down in each direction; posterior segment occupying three fifths the length of the axis.

"Dimensions of complete specimen collected by Mr. R. Rhodes for the Geological Survey: Total length, 13·3 mm.; head, length 5·6 mm., breadth 6·3 mm.; tail, length 5·2 mm., breadth 6·2 mm.

"*Affinities.*—*A. callavei* and *A. dux*, associated on the same horizon, closely resemble one another in general shape and relief, the flatness of the margins of the head- and tail-shields, and the details of the thoraces. They differ greatly in the length and shape of their glabella and tail-axis and in the furrows over their glabella, in the form of which *A. callavei* is perhaps unique. Their great differences are remarkable in being combined with such close similarities. The suggestion presents itself that they may possibly be male and female of the same species, but the differences are perhaps too great for this to be entertained. Nevertheless, the resemblances are such that both can best be compared with the same forms, viz., with *A. glabratus* and *A. lentiformis*, Angelin, and *A. sidenbladhi*, Linnrsn. *A. callavei* also shows a close resemblance to *A. vir* var. *concinnus*, Matthew, from the *Paradoxides* shales of the St. John Group, Newfoundland, which latter differs chiefly in the greater length of the tail-axis as well as in the glabella furrow.

[1] I cannot avoid a suspicion that these grooves may be adventitious. They are approximately in line with cracks upon the cheeks, and may possibly have been produced by pressure upon the tubercle. Nevertheless, they seem like actual furrows and not cracks.—P.L.

"*Horizon and Locality.*—Tremadoc: collected by Mr. R. Rhodes for the Geological Survey from the Shineton Shales of Shropshire, in Shineton Brook at 18—20 chains S.W. of Shineton Church and also in the stream, Mary's dingle, 11 chains W.S.W. of Morell's Wood."

23. **Agnostus cyclopyge,** Tullberg. Plate II, figs. 21, 22.

1868. *Agnostus obtusus* (pars), Belt, Geol. Mag., vol. v, p. 10, pl. ii, figs. 15, 16 (tails only).
1880. *Agnostus cyclopyge,* Tullberg, Agnostus-arterna, p. 26, pl. ii, fig. 15 *a, c.*

Head rounded, with a fairly wide margin. Glabella bilobed, but the furrow separating the two lobes very faint; the anterior lobe rounded in front; the posterior lobe slightly constricted towards the middle, the anterior corners swollen into small nodules, and a median tubercle also present; basal lobes fairly large. Cheeks nearly uniform in width throughout, separated in front of the glabella by a deep groove.

Tail somewhat quadrate, surrounded by a wide margin, which is produced into short lateral spines at the posterior angles. The axis, so far as it is distinct from the rest of the tail, is very short, about one third the total length, pentagonal in shape, bounded laterally by two nearly parallel furrows and posteriorly by two furrows which meet at a very obtuse angle and are produced somewhat beyond the lateral furrows before they die out; at the angle where these furrows meet there is a small tubercle or keel. The rest of the tail is uniformly smooth and but little convex.

Head- and tail-shields about 3 mm. long and 3—3·5 mm. wide.

There is no species with which this form is likely to be confounded. The characters of the tail are quite unique, and the glabella is unlike that of any other British species.

Belt's figure of *A. obtusus* is very imperfect, but the specimen with his label in his collection (now in the British Museum) shows that the tail is identical with that of *A. cyclopyge.* On the same slab occur heads which are decidedly different from the head of *A. cyclopyge* as figured by Tullberg, and it is apparently from these that Belt has drawn his description of the head of *A. obtusus.* He even figures a complete specimen with the head and thorax attached to the tail, but unfortunately this specimen is not now to be found. In the Oxford Museum, however, there is a complete specimen from the Black Shales of Malvern; and though the head is not in a very good state of preservation, it is sufficient to show that it agrees with Tullberg's description and not with Belt's. It appears best, therefore, to restrict Belt's name *A. obtusus* to the heads which he described. It must, however, be admitted that the specimen in the Belt collection would lead one to infer that the heads and tails belong to the same species.

Type.—Specimen 58494 in the British Museum (Natural History) belonging to the Belt collection, probably includes some of Belt's original types.

Horizon and Localities.—Upper Lingula Flags: White-leaved Oak, Malvern; Dolgelly.

24. **Agnostus obtusus,** Belt. Plate II, fig. 23.

1868. *Agnostus obtusus*, Belt, Geol. Mag., vol. v, p. 10, pl. ii, figs. 15, 16 (heads only).

Head quadrate, with a wide margin. Glabella bilobed; the anterior lobe quadrate and but faintly separated from the posterior lobe; posterior lobe nearly parallel-sided, with a prominent central tubercle near its front margin; basal lobes large and triangular, meeting behind the posterior lobe. Cheeks nearly uniform in width throughout, confluent in front of the glabella.

Head about 3 mm. long and 3—3·5 mm. wide.

Under the description of *A. cyclopyge* I have given reasons for referring to that species the tail which Belt ascribed to this head. If this view be correct, the tail of *A. obtusus* is still unknown. The species, however, probably belongs to the section Limbati.

Type.—Probably specimen 58494 in the British Museum (Natural History).

Horizon and Locality.—Upper Lingula Flags: Dolgelly.

Section Parvifrontes.

25. **Agnostus truncatus,** Brögger. Plate II, fig. 24.

1875. *Agnostus*, n. sp., Brögger, Geol. För. Stockh. Förh., vol. ii, pl. xxv, fig. 1.
1879. *Agnostus truncatus*, Brögger, Nyt Mag. for Naturv., vol. xxiv, p. 72, pl. vi, fig. 8.
1896. *Agnostus parvifrons*, var. *truncatus*, G. F. Matthew, Trans. N. Y. Acad. Sci., vol. xv, p. 222.

Head rounded in outline, gently convex, with narrow margin. Glabella, which seems to represent only the posterior and basal lobes, short, barely half the total length of the head, bounded by nearly parallel lateral furrows, and by a straight transverse furrow in front; basal lobes small.

Thorax: axis with a lateral nodule on each side; pleuræ grooved.

Tail semi-elliptical, with narrow margin. Axis fairly wide, somewhat constricted about one quarter of its length from the front; anterior segment completely defined by a shallow furrow and very short; second and third segments not distinctly separated, with an elongated tubercle extending through what appears

PLATE I.

Fig. Page.

Agnostus fissus, Lundgren. 3

1. Complete individual, somewhat compressed laterally. Menevian; Nine Wells, St. David's. Sedgwick Museum, Cambridge.

2, 3. Heads. Menevian; near Nine Wells, St. David's. Sedgwick Museum, Cambridge.

Agnostus punctuosus, Angelin. 4

4. A somewhat flattened specimen. Menevian; Porth-y-rhaw, St. David's. Sedgwick Museum, Cambridge. (Figured by Hicks as *Agnostus scarabæoides,* Quart. Journ. Geol. Soc., vol. xxviii, pl. v, fig. 8.)

5. Tail of a young individual. Menevian; Porth-y-rhaw, St. David's. Sedgwick Museum, Cambridge. (Figured by Hicks as *Agnostus scutalis,* Quart. Journ. Geol. Soc., vol. xxviii, pl. v, fig. 9.)

6. Tail of a still younger individual. Menevian; Porth-y-rhaw, St. David's. Sedgwick Museum, Cambridge. (Figured by Hicks as *Agnostus scutalis,* Quart. Journ. Geol. Soc., vol. xxviii, pl. v, fig. 10.)

Agnostus davidis, Salter. 6

7. One of Hicks's types. Menevian; Porth-y-rhaw, St. David's. Sedgwick Museum, Cambridge. (Figured by Hicks, Quart. Journ. Geol. Soc., vol. xxviii, pl. v, fig. 2.)

Agnostus exaratus, Grönwall. 6

8. Complete specimen, much compressed laterally. Menevian; Porth-y-rhaw, St. David's. Sedgwick Museum, Cambridge. (Figured by Hicks as *Agnostus scutalis,* Quart. Journ. Geol. Soc , vol. xxviii, pl. v, fig. 12.)

9. A more incomplete but much better preserved specimen. Menevian; St. David's. Sedgwick Museum, Cambridge.

10. Tail and thorax. Menevian; near Nine Wells, St. David's. Sedgwick Museum, Cambridge.

Agnostus reticulatus, Angelin. 8

11. Complete specimen. Lower Maentwrog beds; Dolgelly. British Museum, no. I. 7343.

Agnostus pisiformis, Linnæus. 9

12. Copy, enlarged to five diameters, of Tullberg's figure, Om *Agnostus*-arterna, pl. ii, fig. 14 *a*, *b*.

Agnostus pisiformis, var. **obesus,** Belt. 9

13. Form with comparatively narrow pygidial axis. Lingula Flags; Trefgarn Bridge, Haverfordwest. Collected by Mr. V. M. Turnbull. Sedgwick Museum, Cambridge.

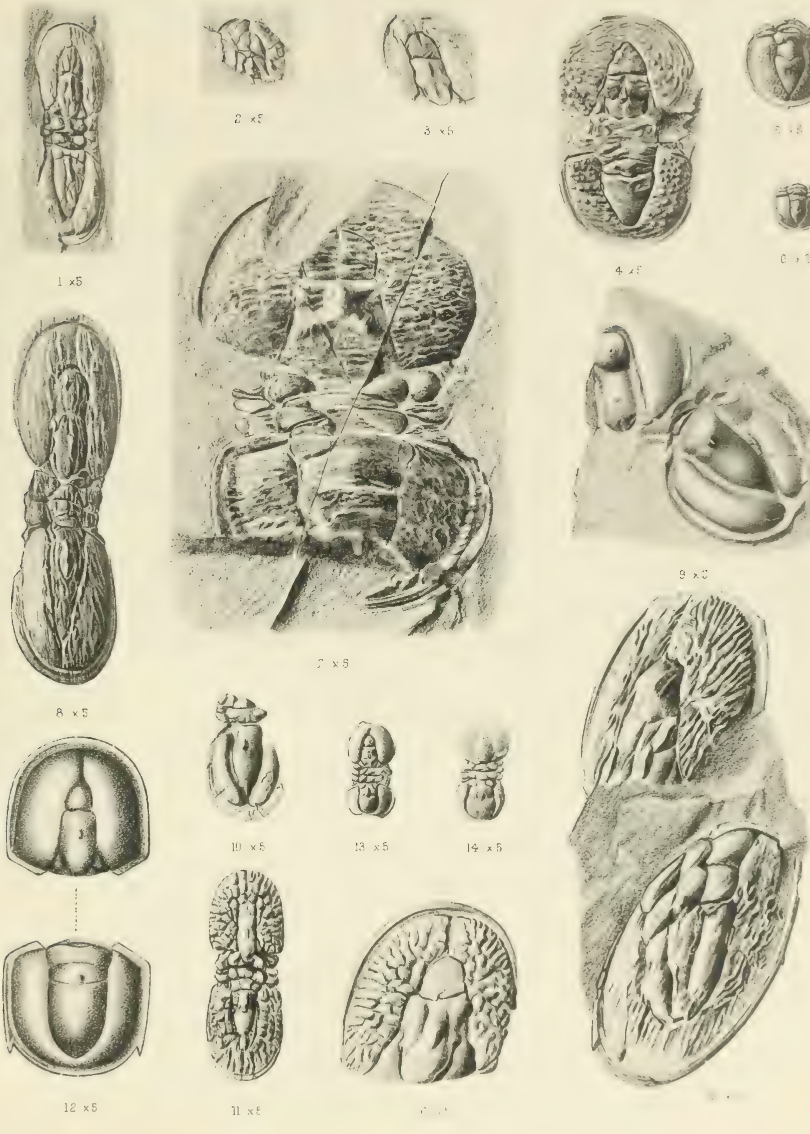
14. Form with pygidial axis much swollen; the head is very imperfectly preserved and consequently does not show the groove in front of the glabella. Lingula Flags; Trefgarn Bridge, Haverfordwest. Collected by Mr. V. M. Turnbull. Sedgwick Museum, Cambridge.

Agnostus trisectus, Salter. 10

15. A large specimen, with the details of the surface well preserved. Upper Lingula Flags; Ogof ddu, Criccieth. Collected by Mr. W. G. Fearnsides. Sedgwick Museum, Cambridge.

16. A somewhat flattened head. Upper Lingula Flags; Moel Gron. Sedgwick Museum, Cambridge.

All the figures are five times the natural size.



AGNOSTUS.

T. A. Brock, del.

PLATE II.

FIG. PAGE.

Agnostus altus, Grönwall. 12

1. A much distorted and somewhat flattened specimen. Menevian; Waterfall Valley, Maentwrog. Sedgwick Museum, Cambridge.

Agnostus barrandei, Salter. 13

2. One of Hicks's figured types. Menevian; Pen-pleidiau, St. David's. Sedgwick Museum, Cambridge. (Figured by Hicks, Quart. Journ. Geol. Soc., vol. xxviii, pl. v, fig. 5.)

Agnostus rotundus, Grönwall. 14

3, 4. Nearly complete, but very much distorted specimens. Menevian; St. David's. Museum of Practical Geology, nos. 8744 (fig. 3) and 8749 (fig. 4).

Agnostus nudus (Beyrich). 15

5. A poorly preserved specimen; the thoracic segments cannot be distinguished owing to the state of preservation. Menevian; Dolgelly. British Museum, No. 58482.

Agnostus eskriggei, Hicks. 16

6. The only specimen known. Menevian; Porth-y-rhaw, St. David's. Sedgwick Museum, Cambridge. (Figured by Hicks, Quart. Journ. Geol. Soc., vol. xxviii, pl. v, fig. 7.)

Agnostus barlowi, Belt. 16

7. The most nearly perfect specimen in the Belt Collection. Stated by Belt to be from the Lower Tremadoc, Dolgelly; but the horizon probably wrong. British Museum, no. 58498. (Probably the original of one of Belt's figures in Geol. Mag., vol. v, pl. ii, figs. 17, 18.)

Agnostus cambrensis, Hicks. 17

8. Head. Harlech Series; St. David's. Sedgwick Museum, Cambridge.
9. Tail. Harlech Series; St. David's. Sedgwick Museum, Cambridge.

Agnostus integer (Beyrich). 18

10. A somewhat distorted specimen. Menevian; Porth-y-rhaw, St. David's. Sedgwick Museum, Cambridge. (Figured by Hicks as *Agnostus cambrensis*, Quart. Journ. Geol. Soc., vol. xxviii, pl. v, fig. 1.)

Agnostus securiger, sp. nov. 20

11. A complete individual. Cambrian; Chapel End, near Nuneaton. Collected by Mr. Sykes.

Agnostus fallax, Linnarsson. 20

12. Head. Menevian; Porth-y-rhaw, St. David's. Sedgwick Museum, Cambridge.

Fig.		Page.

Agnostus rudis, Salter pars. 21

13, 14. Heads. Upper Lingula Flags; Penmorfa Church. Museum of Practical Geology, nos. 8728 (fig. 13) and 8725 (fig. 14).

15. Tail. Upper Lingula Flags; Penmorfa Church. Museum of Practical Geology, no. 8723.

16. Tail. Upper Lingula Flags; Ogof ddu, Criccieth. Collected by Mr. W. G. Fearnsides. Sedgwick Museum, Cambridge.

Agnostus sidenbladhi, Linnarsson. 22

17. Complete individual. Tremadoc Beds; Penmorfa. Collected by Mr. W. G. Fearnsides. Sedgwick Museum, Cambridge.

Agnostus calvus, sp. nov. 23

18. A complete individual. Tremadoc Beds; Nant rhos ddu, Arenig. Collected by Mr. W. G. Fearnsides. Sedgwick Museum, Cambridge.

Agnostus dux, Callaway. 24

19. The largest specimen known. Shineton Shales; Shineton. Birmingham University Museum. (Figured by Callaway, Quart. Journ. Geol. Soc., vol. xxxiii, pl. xxiv, fig. 3.)

Agnostus callavei, F. Raw. 25

20. A large individual. Shineton Shales; Shineton. Collected by Mr. Rhodes for the Geological Survey.

Agnostus cyclopyge, Tullberg. 27

21. A complete but poorly preserved specimen; the actual specimen is an impression only, and the drawing is made from a wax cast. Upper Lingula Flags; White-leaved Oak, Malvern. Oxford University Museum.

22. Tail. Upper Dolgelly Beds; Dolgelly. British Museum, no. 58494. (Belt's figures of *Agnostus obtusus*, Geol. Mag., vol. v, pl. ii, figs. 15, 16, are probably taken from the specimens on this slab.)

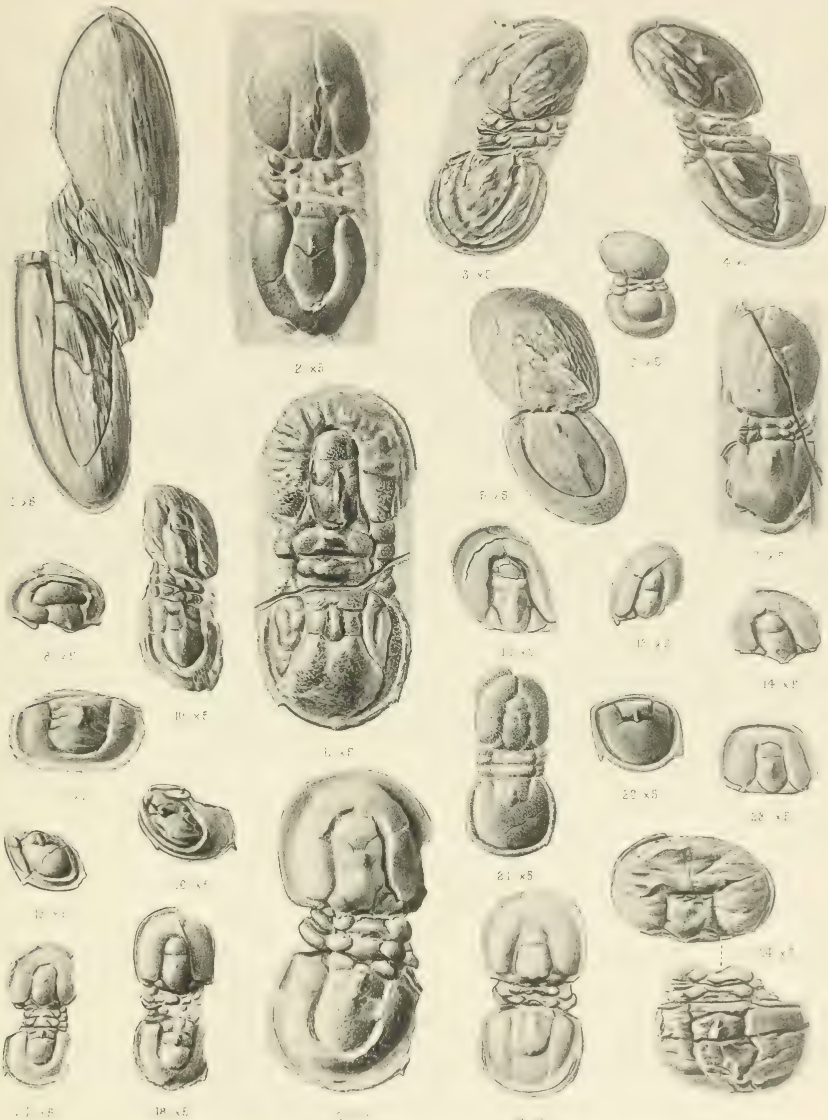
Agnostus obtusus, Belt. 28

23. Head. Upper Dolgelly Beds; Dolgelly. British Museum, no. 58494. (Belt Collection. On the same slab as fig. 22.)

Agnostus truncatus, Brögger. 28

24. Complete but distorted specimen. Menevian; Solva. Collected by Mr. C. H. O. Curtis. Sedgwick Museum, Cambridge.

All the figures are five times the natural size.



AGNOSTUS.

T. A. Brock. del.
1906.

Palæontographical Society, 1906.

A MONOGRAPH

OF

BRITISH GRAPTOLITES.

BY

GERTRUDE L. ELLES, Sc.D.,

LATE GEOFFREY FELLOW, NEWNHAM COLLEGE, CAMBRIDGE;

AND

ETHEL M. R. WOOD, D.Sc.

[Mrs. SHAKESPEAR],

OF NEWNHAM COLLEGE, CAMBRIDGE; AND THE UNIVERSITY OF BIRMINGHAM.

EDITED BY

CHARLES LAPWORTH, LL.D., F.R.S.,

PROFESSOR OF GEOLOGY IN THE UNIVERSITY OF BIRMINGHAM.

PART V.

Pages lxxiii—xcvi, 181—216; Plates XXVI, XXVII.

LONDON:

PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.

1906.

PRINTED BY ADLARD AND SON, LONDON AND DORKING.

which possessed considerable flexibility, consists of two layers: (1) an *inner* layer of considerable thickness, generally marked by transverse lines which meet on the upper and lower surfaces of the cells so as to form a zigzag line, but in a few cases quite smooth (as in *M. Sedgwickii*, *M. convolutus*, etc.); and (2) an *upper* layer consisting of two thin lamellæ, so thin that the ornamentation of the inner layer is seen through. This outer layer is rarely preserved. The same two layers occur in *Retiolites*, but the double character of the upper layer is not yet determined.

In this paper also Richter was the first definitely to describe and figure as an independent structure in the genus *Monograptus* the initial Graptolite body now known as the "sicula." He calls it the *foot* or *haft-organ*. The shape of this "foot"—pointed, cone-like, rounded at the lower end—is admirably given in his figure of *M. priodon*, and he recognises the fact that the canal arises from this "foot." Richter also observes that the presence of the "foot" at the base of single-branched forms shows clearly that they are independent forms, and not merely branches of forms belonging to compound genera.

Richter considers that the axis of Graptolites is solid and of a fibrous structure, lies in a groove of the inner skeletal layer, is covered by the outer double one, and consists of as many parts as there are rows of cells. Even when the groove is sinuous, as in *D. teretiusculus*, the axis is quite straight. In *Diplograptus* he holds that there is only one canal and one axis, and he does not agree with Hall that in *Phyllograptus* there are four of each. The peculiar structure of the cells in *D. teretiusculus*, as interpreted by him, is described in detail, and illustrated by figures. Examples of the varieties of apertural ornamentations are given, especially in the case of *Rastrites*. These, he considers, are formed of the double upper layer. He believes that in *Rastrites* the apertures of the cells, which scarcely project beyond the common canal, are situated in the axil of the spine, the "cells" of previous authors being merely ornamental processes.

As regards the development of the Graptolites, he observes that nothing like the reproductive capsules described by Nicholson and Hall has been found in Germany; but he notices the occurrence of isolated "feet" with long, lash-like threads at their pointed ends. In *Monograptus* the first cell arises on the ventral side of the "foot"; in *Diplograptus* a cell arises from each side of the broader end of the "foot," but at different levels. He has noticed, in association with Graptolites, great numbers of spherical bodies, apparently surrounded by a double membrane, but he does not offer any suggeston as to the nature of these bodies, or the cause of this association.

His views of the mode of life of the Graptolites are remarkable. He thinks that the "foot" was movable, and could be turned upwards or downwards. When turned downwards it could be used to support the polypary vertically, by sticking into the mud. Some species, perhaps, could move freely from place to place, which

would account for the fact that the full-grown forms do not occur in such groups as do the small individuals, but are scattered among other species.

The affinities of the Graptolites with the Pennatulidæ, Sertularidæ and Polyzoa are discussed, and Richter concludes that they are most closely allied to the last named. He adduces the rod of Rhabdopleura in support of his views, and compares the thin laminæ of the Graptolites to those of the cells and endocysts of a Polyzoon.

Other points are touched upon and discussed by Richter, such as the food of the Graptolites, their length of life, existence of enemies, etc., but nothing new in these directions is added to the views expressed by him in previous papers.

1871.
Linnarsson,
" Om några Försteningar från Sveriges och NorgesPrimordialzone," 'Kongl. Vet. Akad. Förh.,' no. 6.

In 1871, also, Linnarsson described and figured a few fragments of a new species—(1) *Dichograptus* **tenellus** (*Clonograptus*), from the upper part of the Olenus shales in Westrogothia. This was the first instance of the occurrence of true Graptolites (excluding *Dictyonema*) in beds then regarded as being of true Cambrian (Primordial) age.

1871.
Lapworth, C.,
"On the Silurian Rocks of the Counties of Roxburghand Selkirk," 'Brit. Assoc. Reports,' and 'Geol. Mag.,' vol. viii.

In a paper read at the Edinburgh Meeting of the British Association and afterwards published in the 'Geological Magazine,' Lapworth and Wilson separated the Silurian strata of Roxburgh into five groups : the Hawick Rocks, the Selkirk Rocks, the Moffat Series, the Gala Group, and the Riccarton Beds, the last three of which are characterised by special graptolitic faunas. The rich graptolitic black shales of the Uplands are all referred to a single Moffat band which occurs not only in the country between Selkirk and Melrose, but re-appears in the Moorfoot Hills to the north.

1872.
Hopkinson,
" On Callograptus radicans, a new Dendroid Graptolite," 'Geol. Mag.,' vol. ix.

In the following year, 1872, three papers were published by Hopkinson.

In the earliest of these he described a new species of *Callograptus* (*C.* **radicans**) from the Arenig rocks of the St. David's district. He gives a full diagnosis of the genus.

He discusses the affinities of the Dendroidea and considers that while *Dendrograptus* and *Ptilograptus* fall naturally into already accepted families of the Thecaphora (or Sertularina), *Callograptus* and *Dictyonema* (the latter being more Polyzoan than Hydrozoan in its affinities) should form a new family.

1872.
Hopkinson,
" On the Occurrence of a Remarkable Group of Graptolites in the Arenig Rocks of St. David's, South Wales," ['Geol. Mag.,' vol. ix.

In Hopkinson's second paper he gives a list of graptolites from the Arenig rocks of St. David's. This list is preliminary to the paper by himself and Lapworth, which appeared three years later, when the various species were described and figured.

1872. *Hopkinson,* "On some Species of Graptolites from the South of Scotland," 'Geol. Mag.,' vol. ix.

Hopkinson's third paper contained a description of several new species from the South of Scotland.

The first two, according to him, do not belong to the Graptolitidæ proper, but are nearly allied forms. Order, Hydroida, Sub-order, Athecata? Family, Corynidæ.—(1) *Corynoides* **gracilis,** (2) *Dendrograptus* **ramulus.** Sub-order, Rhabdophora, Fam. Monoprionidæ, (3) *Gr.* **attenuatus,** (4) *Gr.* **acutus,** (5) *Diplogr.* **Etheridgii,** (6) *D.* **penna,** (7) *D.* **pinguis,** (8) *D.* **fimbriatus,** (9) *D.* **Hincksi,** (10) *Dicranog.* **rectus.**

Hopkinson, in discussing the age of the Moffat shales, acknowledges it as probable that but one band of black graptolitic shale runs through the Llandeilo rocks of the South of Scotland, there being in this band "several distinct zones, each marked by a different assemblage of fossils, but with many species in common."

1872. *Nicholson,* "On the Migrations of the Graptolites," 'Quart. Journ. Geol. Soc.,' vol. xxviii.

A paper by Nicholson in this year "On the Migrations of the Graptolites" is mentioned here because of its historical value. His conclusions may be thus summarised:—The Skiddaw fauna was the oldest in Britain and migrated into Wales, Ireland, and America, four species only migrating northward into the Moffat area. The South of Scotland became a second centre of dispersion at the end of the Upper Llandeilo period, one migration proceeding southwards into the Lake district, founding the fauna of the Coniston group, and another going westward through Ireland to America and originating the fauna of the Hudson River group and that of the Utica Slates, while a third travelled in a south-east direction into the Silurian seas of Saxony and Bohemia.

1872. *Lapworth,* "Note on the Results of some Recent Researches among the Graptolitic Black Shales of the South of Scotland," 'Geol. Mag.,' vol. ix.

In a short note published in the 'Geological Magazine,' towards the end of 1872, Lapworth summarised his views on the age and stratigraphical relations of the Moffat Shales, as partly given in a paper read by him at the beginning of the year before the Geological Society of Glasgow (subsequently published, with additions, in the 'Transactions' of that Society, vol. iv, p. 164). He points out that there are three main divisions, "lithologically and palæontologically separable"; which "naturally subdivide into several distinct zones, each characterised either by the exclusive possession of some well-marked species, or by the constant possession of some peculiar group of species."

1872. *Nicholson,* 'A Monograph of the British Graptolitidæ.'

During the same year Nicholson published the first part (the "General Introduction") of his 'Monograph of British Graptolitidæ,' a work unfortunately never completed. It is of especial historical interest, as giving a complete summary

of the views then held by himself and others as to the nature, structure, reproduction, classification, etc., of the Graptolites. The Introduction is divided into nine chapters.

CHAPTER 1.—*Historical Notices*, summarising the progress of research among the Graptolites from the time of Linnæus to 1872.

CHAPTER 2.—*Form and Mode of Preservation of Graptolites.*—In discussing the mode of nomenclature to be employed in describing a graptolite, Nicholson here first suggests the title of "polypary" for the whole of the graptolite skeleton. He adheres to the old term "calycles," or "cellules," declining to adopt the term "hydrothecæ."

The various states of preservation in which Graptolites occur are described. The carbonaceous material of the rock in which they are generally preserved is considered to be of "animal origin," and can "hardly be ascribed to anything else except the Graptolites themselves."

CHAPTER 3.—*General Morphology of Graptolites.*—In this chapter Nicholson describes in considerable detail the structure of a typical Monoprionidian and a Diprionidian form, and the various aspects—"profile," "axial," and "scalariform" —under which they may be seen.

CHAPTER 4.—*Special Morphology of Graptolites.*—(1) *Solid Axis.* The hollow character of this structure previously suggested by him is again asserted, and this time with more certainty. The curious tube-like rod in the Rhabdopleura he considers "lends great support to this view." This also explains the apparent ability of the axis to grow independently of the rest of the polypary, and to prolong itself distally as in species of *Diplograpsus.* The distal extension of the axis is very rare in *Monograpsus*, and never exists in *Didymograpsus*, *Cœnograpsus*, etc. He considers that the axis is never present in the shape of a "thin, flat, apparently double plate" as believed by Barrande ('Grapt. de Bohême,' p. 4), and Hall ('Grapt. Quebec Group,' p. 22).

The character and position of the axis in *Phyllograpsus*, *Retiolites*, and *Trigonograpsus* are discussed; the fact that the axis is *inside* and not outside the polypary in the two latter genera is insisted upon, while the absence of any axis whatever in the Dendroidea is remarked.

(2) *Surface Markings and Ornamentation of the Polypary.*—The striæ observed running parallel with the aperture of the cells are for the first time described as "growth lines," and good figures are given of the "pustules" visible at the base of the cell walls, especially in *M. vomerinus.*

CHAPTER 5.—*Nature and Function of the Base in the Graptolites.*—(1) *Radicle.* The form of the so-called "radicle" or "initial point" as then accepted is more clearly represented in this work than in previous papers, and it is distinguished from the "radicle" as referred to by Hall, by which he meant merely the commencement of the solid axis. Nicholson, however, did not realise the invariable

presence of the initial cone-shaped body (the sicula) in all Graptolites, and he uses the term "radicle" to "signify the basal median process," "whether this consists of the solid axis alone, or of the solid axis along with the common body, or simply of the investing envelope of the latter."

(2) *Funicle* and (3) *Central Disc.*—Both these structures are described practically from Hall's point of view, and the former opinions held by Nicholson as to the "float"-like character of the latter are adhered to.

CHAPTER 6.—*Reproduction and Development.*—The various "ovarian vesicles" previously described by himself are re-described, and he changes his previous title of "Grapto-gonophores" to the more precise hydroidal title of "gonothecæ." The peculiar sac-like bodies figured by Hall (1865) and Hopkinson (1871) in specimens of *D. Whitfieldii* and *D. pristis* are considered by Nicholson to be also reproductive in function.

CHAPTER 7.—*Zoological Position of the Graptolites.*—(1) *Mode of Existence.* The free-floating habit of the true Graptolite is strongly emphasised, and consequently the systematic separation of the fixed Dendroidea from the true Graptolites is considered inevitable.

(2) *Systematic Position and Affinities.*—These questions are entered into very fully, and the various points of resemblance and difference between the Graptolites and (1) the Actinozoa, (2) the Polyzoa, and (3) the Hydrozoa are discussed in much detail. The general conclusion reached is, that they "find their *nearest* living allies in the Sertularians," and are "truly referable to the Hydrozoa," though they "cannot be placed in any living group of the Hydrozoa."

CHAPTER 8.—*Geological Distribution.*—The author's general views of the range and distribution of the Graptolites differ in no essential particulars from those expressed in previous papers, and need not here be referred to.

CHAPTER 9.—*Genera.*—The final chapter is devoted to a classification of the Graptolites, and to a description of the various genera, which are thus arranged:

Class, Hydrozoa, Sub-class Graptolitidæ.

Section A.—Monoprionidæ, Hopk.: (1) *Graptolites* or *Graptolithus;* (2) *Didymograpsus* (including *Dicellograpsus*); (3) *Tetragrapsus;* (4) *Dichograpsus;* (5) *Loganograpsus;* (6) *Pleurograpsus;* (7) *Cœnograpsus*, Hall (= *Helicograpsus*, Nich.); (8) *Cyrtograpsus;* (9) *Rastrites.*

Section B.—Diprionidæ: (10) *Diplograpsus;* (11) *Climacograpsus;* (12) *Dicranograpsus;* (13) *Retiolites;* (14) *Trigonograpsus;* (15) *Retiograpsus.*

Section C.—Tetraprionidæ: (16) *Phyllograpsus.*

Section D.—Dendroidea: (17) *Ptilograpsus;* (18) *Dendrograpsus;* (19) *Callograpsus;* (20) *Dictyonema.*

Section E.—Incertæ Sedis: (21) *Thamnograpsus:* (22) *Buthograpsus;* (23) *Inocaulis;* (24) *Corynoides.*

1872.
Allman,
'A Monograph of the Gymnoblastic or Tubularian Hydroids.'

The year 1872 was also marked by the appearance of Allman's classical monograph on the 'Gymnoblastic or Tubularian Hydroids,' in which a considerable section is devoted to the discussion of the affinities of the Graptolites. Accepting without criticism the views already current among palæontologists as to the structure of these fossils, Allman draws from them some highly original and suggestive conclusions as to the homologies of the various organs. He considers that it is doubtful whether such anomalous forms as *Retiolites* and *Phyllograptus* should be included among the Graptolitidæ, while forms like *Corynoides*, *Dendrograptus*, and especially *Dictyonema*, are "almost certainly not Graptolites."

Acknowledging that the resemblance of the polypary in the Graptolites to the trophosome of a calyptoblastic Hydroid—Sertularian or Plumularian—is "sufficiently obvious," Allman considers that while their affinities with the Hydroida "are too decided to justify their omission from any complete exposition of the palæontological history of this group of the animal kingdom," yet their peculiar characters "necessitate the establishment for them of a separate sub-order of Hydroida." For this he proposes the name **Rhabdophora** (Rhabdos = rod), from the presence of the characteristic solid axis or virgula. The Polyzoan affinities of the Graptolites are very briefly discussed, but he admits that "were it not for the discovery of the graptolite gonosome, we should have nearly as much to say for this view as for that which would refer them to the Hydroida."

Allman discusses at considerable length the homologies of the most characteristic structure of the Graptolite, viz. the virgula or axis, "the presence of which can hardly be regarded as offering an insurmountable obstacle to the admission of the Graptolites into immediate relation with the Hydroida." He regards it, like the perisarc, as "an excretion from the cœnosarc." The distal and probably the proximal prolongation of a naked axis beyond the celluliferous part of the polypary he considers to be probably only an apparent phenomenon. He says that there is "reason to believe that the cœnosarc invested by a proper perisarc was originally continued" along the rod, but this perisarc on account of its delicacy has not been preserved.

Denticles.—Perhaps the most original part of this work is that in which Allman suggests that the structures in the living Hydroida homologous with the denticles of the Graptolites are not the hydrothecæ but the nematophores, such as those of *Aglaophenia*, which contain simple protoplasm and not true hydranths. He points out that it is not only in general form that the nematophores resemble the Graptolite-cells, but also in their method of communication with the common canal, for the continuous and open communication of the calycles of Graptolites with the main tube is very different from the constricted communication (often associated with an imperfect diaphragm) which exists between the hydrothecæ and the

perisarcal tube in the Hydroids. If this suggestion is correct, then the Graptolites would be "morphologically Plumularidans in which the development of hydrothecæ had been suppressed by the great development of the nematophores," "while on the other hand, the existing Plumularidian" "would present in its nematophores the last traces of the structure of its ancient representative, the Graptolite."

Reproductive Organs.—Allman accepts the "gonosomal" nature of the reproductive sacs described by Hall and Hopkinson in *Diplo. pristis*, but rejects the "ovarian vesicles" of Nicholson, regarding their connection with the Graptolite as probably "purely accidental." Although admitting the probability that the appendages observed by Hall belong to the generative system, he is "unable to satisfy" himself that they are the remains of gonangia; indeed he thinks that they are not capsules at all but "hollow laminæ." He finds an analogue to these in the leaflets which compose the corbulæ in *Aglaophenia*. An explanation of the scarcity of these "corbulæ" in the case of the Graptolites is hinted at "in their free if not floating habit," for while no specimen of *Sargassum* in fructification has been discovered in the Sargasso Sea, the fructification of closely allied species which grow attached to rocks, etc., is not at all uncommon.

Allman in a subsequent note to this work briefly refers to Richter's views on the structure of Graptolites as given in his paper in 1871. He expresses considerable doubt as to the presence of two laminæ in the test, and of the development of the common canal from the "foot," and says that he is "unable to find in Richter's arguments any grounds for accepting the Polyzoal affinities of Graptolites," although the striæ observed by him in the Graptolites compare well with those in *Rhabdopleura*.

1873.
Hopkinson,
"On some Graptolites from the Upper Arenig rocks of Ramsay Island, St. David's.,"
'Geol. Mag.,' vol. x.

Some further facts regarding the occurrence of Graptolites in the St. David's district were furnished by Hopkinson in 1873. He gives a list of seven species from the Upper Arenig Rocks of Ramsay Island.

1873.
Hopkinson,
"On the Occurrence of Numerous Species of Graptolites in the Ludlow Rocks of Shropshire,"
'Geol. Mag.,' vol x.

The same year Hopkinson wrote a note "On the Occurrence of Numerous Species of Graptolites in the Ludlow Rocks of Shropshire," adding very considerably to our knowledge of the fauna of these rocks. Six species of *Monograptus* and two of *Ptilograptus* were new forms, viz., *M.* **capula**, *M.* **clavicula**, *M.* **incurvus**, *M.* **leintwardinensis**, *M.* **Salweyi**, *M.* **serra** (the three last alone are now identifiable), *Ptilog.* **elegans**, and *P.* **Nicholsoni**.

1873.
Nicholson,
"On some Fossils from the Quebec Group of Point Levis."
'Ann. and Mag. Nat. Hist.,' ser. 4, vol. xi.

In 1873 Nicholson described some new Graptolite species collected by himself from the shales of Point Levis, *viz.*, *Dictyonema* **grandis**, *Tetragraptus* **approximatus**. In this paper the generic name **Clonograptus** (for such forms as *Gr. flexilis* and *Gr. rigidus*) was first used. This name was given by Hall at Nicholson's request. The three genera *Clonograptus*, *Loganograptus* and *Dichograptus* are clearly defined and distinguished.

Nicholson had by no means given up his idea of the ovarian character of the small capsules found in conjunction with certain species of *Monograptus*, and in this paper he names them, for the sake of convenience, **Dawsonia.** Of these he considers there are four distinct species: *D.* **acuminata**, *D.* **rotunda**, *D.* **tenuistriata**, *D.* **campanulata**.

1873.
Dames,
"Beitrag zur Kenntniss der Gattung *Dictyonema*, Hall,"
'Zeit. d. deutsch. geol. Gesell.' bd. 25.

Fresh light was thrown on the structure of the genus *Dictyonema* by Dames in 1873. In the majority of his observations he agrees with Hall, and he considers that there is no doubt as to its graptolitic nature. In some well-preserved specimens from the Silurian Limestones in Prussia, the cross threads have broken, thus setting free the branches, and the characteristic graptolite cells with long threads coming from their apertures are easily recognisable. Such specimens demonstrate that the cells are in one row only, not in alternating rows on *both* sides as Nicholson had stated.

Dames suggests that *Dictyonema* is allied most nearly to *Dichograptus* and *Dendrograptus*, the branches of which are spread out and are not united by cross threads.

1873.
Stache,
"Die Graptolithen-schiefer am Osternig-Berge in Kärnten," etc.,
'Jahrb. der. k. k. geol. Reichsanstalt,' bd. 23.

In 1873 Stache recorded and gave brief descriptions of some species of Graptolites from Osternig in Carinthia. These include *Diplograpsus folium*, *D. pristis*, *Graptolithus* (*Monograpsus*) *proteus*, *G. triangulatus*, *G. millepeda*, *G. Nilssoni*, *Rastrites*, *sp. Retiolites*, *cfr. Geinitzianus.* From these fossils he concludes that the beds correspond to the Silurian Strata of the Fichtelgebirge and the Thüringian-Saxon Schiefergebirge, and also to the base of Barrande's Stage E., and the Coniston Flags of England.

1873.
Erdmann,
"Graptolith delvis omsluten af en svafvelkisboll," 'Geol. Fören. i Stockh. Förh.' bd. 1, no. 11.

Erdmann figured a Graptolite which he refers to *Gr. sagittarius*, partly enclosed in a nodule of iron pyrites.

1873.
Malaise,
"Note sur la description du terrain Silurien du centre de la Belgique," 'Ann. Soc. Malacologique de la Belgique,' t. 8.

In the same year Malaise recorded the existence of the second Silurian Fauna, containing *Climaco. scalaris* and *Graptolithus priodon* in the Upper part of the Silurian "terrain" in the centre of Belgium; the fossiliferous horizons representing the Upper Caradoc and Lower Llandovery.

1873.
Lapworth,
"Notes on the British Graptolites and their Allies. On an Improved Classification of the Rhabdophora," 'Geol. Mag.' vol. x.

In 1873 Lapworth published a comprehensive paper "On an Improved Classification of the Rhabdophora."

Classification.—Accepting Allman's term Rhabdophora as the collective term for all the presumed virgula-bearing Graptolites, Lapworth separates them into two sections, namely:

Section I. — Graptolitidæ (or **Graptoloidea**), in which the polypary is developed from a true sicula, the cœnosarc originates a single series of thecæ only, and the virgula is dorsal and on the exterior of the periderm.

Section II.—**Retioloidea,** in which the polypary is not developed from a siculiform "germ," the cœnosarc originates a double series of thecæ, and the epiderm is more or less supported by a framework of chitinous filaments.

The Graptoloidea are divided into six families:

1. **Monograptidæ,** distinguished by the nucleated arrangement of the parts. Genera: 1, *Rastrites;* 2, *Monograptus;* 3, *Cyrtograptus.*

2. **Nemagraptidæ** (Hopk. MS.), slender forms, with ornate thecæ and irregular branches. Gen.: 4, **Leptograptus;** 5, **Amphigraptus;** 6, *Nemagraptus;* 7, *Cœnograptus.*

3. **Dichograptidæ,** regularly branched, with prismatic thecæ. Gen.: 9, *Didymograptus;* 10, *Tetragraptus;* 11, *Dichograptus;* 12, *Loganograptus;* 13, *Clonograptus;* 14, 15, 16, 17 (unnamed).

4. **Dicranograptidæ,** two-branched, with incurved thecæ. Gen.: 18, *Dicellograptus;* 19, *Dicranograptus.*

5. **Diplograptidæ,** polypary duplicate. Gen.: 20, *Climacograptus;* 21, *Diplograptus.* (Subgenera: **Glyptograptus,** *Petalograptus, Cephalograptus,* **Orthograptus.**)

6. **Phyllograptidæ,** polypary composite, quadribrachiate. Gen.: 22, *Phyllograptus.*

The Retioloidea are divided into two families:

7. **Glossograptidæ,** virgulæ coalescent, central. Gen.: 23, *Glossograptus;* 24, *Retiograptus;* 25, **Lasiograptus.**

8. **Retiolitidæ,** virgulæ separate, lateral. Gen.: 26, **Clathrograptus;** 27, *Trigonograptus;* 28, *Retiolites.*

This classification is elaborated in a detailed Analytical Table.

Development.—In this paper Lapworth points out for the first time that in all the bilateral genera included in the families assigned to the Graptoloidea, the Graptolite polypary first becomes visible as a small, pointed, triangular, or rather dagger-like "germ," which he names the *sicula* (already recognised by Richter in the case of *Monograptus* and *Diplograptus* only, and denominated by him the "foot"). In the majority of bilateral examples studied a solid axis is developed in the outer wall of the sicula extending along its entire length, and a small protuberance or "bud" makes its appearance usually in the neighbourhood of the sicula, and becomes moulded into a theca: a similar bud is given off from the opposite margin, and from these primordial buds the two main branches of the polypary are evolved by a process of continuous gemmation.

But while the sicula appears always to have been present, the place of origin of the primordial bud or buds is somewhat different in the different genera, and in some forms there still remains a doubt whether the polypary is not a direct outgrowth of the major (*Dichograptus*, etc.) or of the minor (*Monograptus*) extremity of the sicula. The sicula normally ceases to grow after the primordial buds have been given off and may occasionally become imbedded, absorbed, or obsolete; but in the great majority of cases it permanently retains its shape and form. "It is simply this persistent sicula which constitutes the axillary spine in *Dicellograptus*," the "radicular bar" in *Cœnograptus*, and the "radicle" in *Didymograptus*, *Phyllograptus*," etc.

The sicular or dorsal angle of the two main branches of the bilateral Graptolites is adopted by Lapworth as the "angle of divergence," and he points out that it ranges throughout the complete circle. It may be 0°, in which case the branches grow parallel with each other distally along the line of the sicula and coalesce by their dorsal surfaces either for the whole of their length (*Diplograptus*) or for a portion of it only (*Dicranograptus*). It may be less than 180° (*Dicellograptus*) or may exceed 180° (*Didymograptus*), or it may be as high as 360°, when the branches again coalesce (*Phyllograptus*).

Structure.—As respects the structure of the monoprionidian Graptolite Lapworth asserts that "the common portion of the polypary preserved in relief appears to be composed of the conjoined bases of the successive thecæ. These bud from each other in a single linear series. The budding orifices remain permanently open and form together a continuous tube or canal of communication for the conveyance of the common body." He restricts the application of the term *theca* to the "exterior and separable portion of the chamber—in other words, to

that which is capable of being broken off from the common portion." He points out that "the line of junction of the thecæ is thickened and projects into the common canal as a rounded shelf or flange."

As respects the Diplograptidæ he states that "the polypary is merely composed of two of these monoprionidian polyparies placed back to back," their dorsal walls coalescing into a median septum, "between the two laminæ of which the duplicate virgula is imbedded." While he regards this as the normal mode of growth, he states in the sequel that in some forms of the Diplograptidæ the facts go to show that "the common canal was only partially divided, thus in effect communicating with both rows of thecæ as in *Retiolites*."

The peculiar characters of the diprionidian forms grouped as Retioloidea leads Lapworth to the view that they form a very distinct group from that of the typical Diplograptide.

The genus *Glossograptus*, originally suggested by Emmons for forms like *D. spinulosus*, Lapworth considers should be retained, as, in addition to the two long thecal spines, there occur "two opposite longitudinal rows of gigantic, isolated spurs developed along the median line of the periderm at right angles with the thecæ." A new genus, **Lasiograptus,** is proposed for such diprionidian forms as have "a connected network" of minute, inosculating threads, "almost completely surrounding the polypary." The type species (**Lasiograptus costatus**) is described but not figured in this paper.

Three other new genera are described, *i.e.*, **Clathrograptus** (type **C. cuneiformis**), **Leptograptus** (*L. flaccidus*), and **Amphigraptus** (*A. divergens*, Hall).

Lapworth regards the grouping of the first four families as given in his Analytical Table as the natural one, but that of the other families as "temporary and provisional," especially that of the Diplograptidæ.

1873. *Salter, J. W.*, 'A Catalogue of the Collection of Cambrian and Silurian Fossils in the Geological Museum of the University of Cambridge.'

In 1873 Salter published an exhaustive Catalogue of the Cambrian and Silurian Fossils in the Woodwardian Museum at Cambridge, illustrated by some figures. The following species of Graptolites are figured and briefly described: (1) *Dictyonema sociale*, (2) *Graptolithus Hisingeri* (*sagittarius*), (3) *Diplograpsus mucronatus*, (4) *Phyllograptus angustifolius*, (5) *Didymograpsus geminus*, (6) *Tetragrapsus bryonoides*, (7) *Dichograpsus*, sp. *Loganograptus*, (8) *Dendrograpsus furcatule*, (9) *Graptolithus Sedgwickii*, (10) *Rastrites* (*Graptolithus*) *convolutus*, (11) *Rastrites peregrinus*, (12) *Diplog. folium*, (13) *Diplog. pristis*, (14) *Gr. ludensis* (*priodon*), (15) *Retiolites Geinitzianus*.

1874. *Miller, S. A.*, 'Cincinnati Quart. Journ. Sci.,' vol. i, p. 343.

In the year 1874 Miller described under the name of **Megalograptus** a peculiar "large cylindrical form, not a graptolite, bearing fronds with spinose processes, and covered with cellular openings."

1874.
Etheridge, R., junr.,
" Observations on a few Graptolites from the Lower Silurian Rocks of Victoria,"
'Ann. Mag. Nat. Hist.,' ser. 4, vol. xiv.

An important addition to our knowledge of the Graptolitic fauna of Australia was made by Etheridge, junior, in 1874. Several species are recorded, figured, and described: (1) "*Tetragraptus bryonoides*" (*Tetra. serra* and *Didymo. caduceus* (*gibberulus*)), (2) *Tetrag. quadribrachiatus*, (3) *Phyllog. typus*, (4) *Loganograptus Logani* (*Goniograptus*), (5) *Climacog. sp.*, (6) *Diplog. mucronatus* (*Glossograptus* and *Lasiograptus*), (7) *D. pristis*, (8) *Didymog.? fruticosus*, (9) *D. nitidus*, (10) *D. Pantoni?* (= *D. v. fractus*), (11) *G. latus*, which he regards as a fragment of a *Dichograptus*, (12) *Graptolithus sp.*

1874.
M'Coy, Fred.,
'Prodromus of the Palæontology of Victoria,' dec. 1.

The same year M'Coy figured several fine examples of Graptolites from Victoria in the first part of his 'Prodromus of the Palæontology of Victoria.' The only new form named by him is a variety of *G. Logani*, *i. e.* (1) var. **australis**. The other species are very similar to those given in Etheridge's paper. (2) *Phyllograptus folium*, His. var. *typus*, Hall, (3) *Diplog. mucronatus* (= *Glossograptus*), (4) *D. pristis*, (5) *D. rectangularis*, (6) *Diplog.* (*Climacograptus*) *bicornis*, (7) *Graptolithus* (*Didymog.*) *fruticosus*, (8) *Gr.* (*Didymog.*) *quadribrachiatus*, (9) *Gr.* (*Didymog.*) *bryonoides*, (10) *Gr.* (*Didymog.*) *octobrachiatus*.

1874.
Lossen,
" Ueber Graptolithen aus dem Harz," 'Zeit. d. deutsch. geol. Gesell.,' bd. xxvi.

Lossen, during the same year, recorded Graptolites from seven new localities in the Harz, corresponding in age to the Upper Thuringian-Fichtelgebirge graptolite horizon.

1875.
M'Coy, Fred.,
'Prodromus of the Palæontology of Victoria,' dec. 2.

Several additional forms of Australian Graptolites are given in the second part of M'Coy's "Prodromus," which appeared in 1875. One new species is named: (1) *Retiolites* **australis,** from the Wenlock. The other forms described and figured are: (2) *Didymog. extensus*, (3) (*Didymog.*) *caduceus* (under this name are figured specimens of *Didymog. gibberulus* and *Tetrag. Bigsbyi*), (4) *Diplog. palmeus*, (5) *Cladog. ramosus*, (6) *Cladog. furcatus*. All these occur in the Llandeilo. *Gr.* (*Didymog.*) *gracilis*, which he suggests might be made the type of a new sub-genus, is recorded from the Bala. He refuses to accept the genera *Tetragraptus*, *Dichograptus*, etc., considering that the number of stems conjoined is a "character certainly not of generic value."

1875.
Swanston,
" Graptolites, with special reference to those found in co. Down," 'Proc. Belfast Naturalists' Field Club,' ser. 2.

In a paper read before the Belfast Naturalists' Field Club in 1875, Swanston recorded some fifteen species of Graptolites from the Silurian strata at Coalpit Bay, co. Down.

1875. *Nicholson, H. A.*, "On a new Genus and some new Species of Graptolites from the Skiddaw Slates," 'Ann. Mag. Nat. Hist.,' ser. 4, vol. xvi.

A new genus of Graptolites, from the Skiddaw slates, was described by Nicholson in 1875, *viz.* **Azygograptus,** with its type species *A.* **Lapworthi.** This genus, which has but one branch, with the sicula in a similar position to that of *Didymograptus*, Nicholson considers to be intermediate in its characters between *Monograptus Nilssoni* and the *Nemagraptus* of Emmons. A new species of *Thamnograptus*, *T.* **Doveri,** is named. The specific name *Didymog.* **gibberulus** is given to one of the forms originally included under Salter's *D. caduceus.*

1875. *Nicholson and Lapworth*, "On the Central Group of the Silurian Series of the North of England," 'Brit. Ass. Report.'

In a joint paper read before the British Association at Bristol, Nicholson and Lapworth divided the Coniston Mudstones into two distinct groups, the Skelgill and the Knock beds, correlating the former with the Scottish Birkhill beds on account of the similarity of their Graptolites, and the latter with the Gala and Hawick beds. The Coniston Flags are regarded as the equivalents of the Denbighshire Flags and the Riccarton Beds.

1875. *Mallada*, "Sinopsis de las Especies Fósiles que se han encontrado en España," 'Boletin de la Com. Geol.'

In 1875 Mallada gave brief descriptions and figures of some species of Graptolites met with in Spain. These include: (1) *Monograpsus Nilssoni*, (2) *M. latus*, (3) *M. Halli*, (4) *M. Becki*, (5) *M. priodon*, (6) *M. convolutus*, (7) *Diplograpsus palmeus*, and (8) *D. pristis.* The figures are not original, but copies of those of previous authors.

1875. *White, C. A.*

Several new species of Graptolites are described by White in the 'Report of the 100th Meridian.' These are: (1) *Phyllograptus* **Loringi** (very closely allied to *P. typus*) from Utah, from beds belonging to what he calls the Canadian Period. From beds of the Trenton Period he describes (2) *Graptolithus* (*Climacograptus*) **ramulus** (*Dicranograptus*), (3) *Diplograpsus* **hypniformis** (*D. foliaceus*), (4) *D. pristis*? (5) *D. quadrimucronatus*? These occur near Belmont, Nevada.

1875. *Richter, R.*, "Aus dem Thüringischen Schiefergebirge," 'Zeit. d. deutsch. geol. Gesell.,' bd. xxvii, heft 2.

The same year Richter recognised two horizons of Graptolite shales (a Lower and an Upper) in Thüringia, but noted that nearly all the forms met with in the lower occur also in the upper. Two new species are figured and described. (1) *Dicranograptus* **posthumus,** (2) *Monog.* **microdon,** and also (3) *Monog. ludensis* (= *M. Flemingii*), (4) *M. fugax*, (5) *Cyrtograptus* sp. (*C. Murchisoni*?). *M. Nilssoni* is described, but not figured.

The results of Hopkinson's and Hicks' discovery of Graptolites in the St. David's district, which had been noted from time to time, were collected and published in 1875.

1875.
Hopkinson and Lapworth,
"The Graptolites of the Arenig and Llandeilo Rocks of St. David's," 'Quart. Journ. Geol. Soc.,' vol. xxxi.

The classification of the Rhabdophora, proposed by Lapworth in 1873, is adopted, but in addition a new sub-order, entitled **Cladophora,** is proposed by Hopkinson to embrace all the remaining Graptolithina. This Sub-order is divided into two sections: (1) Thamnoidea, with its family, Thamnograptidæ and its genera *Thamnograptus* and *Buthograptus*, and (2) Dendroidea, with its families Ptilograptidæ and Callograptidæ, the latter family including the genera *Dendrograptus*, *Callograptus*, and *Dictyograptus*, with its new Sub-genus **Desmograptus.**

An attempt is made to render the nomenclature of the Graptolites more uniform, by employing the termination "graptus" in the names of all the genera, as, for example, *Rastrograptus*, *Gladiograptus*, etc.

Terminology.—A section of the paper is devoted to the terminology employed in describing the Graptolites. The "sicula" is carefully distinguished from the "radicle"; but the latter term is still employed in Hall's original significance, for the "proximal prolongation of the virgula" whatever its form. The various forms of appendages—*viz.* 1, lateral or peridermal; 2, ventral or thecal; 3, proximal and mesial; 4, apertural; 5, proximal; or 6, radicular—are defined and distinguished.

Description of Species.—The descriptions of the species are concise and accurate, but the figures are poor, and their identification is in some cases a matter of difficulty. The following genera, species, and varieties are given as new: (1) *Didymograptus* **sparsus,** (2) *D.* **Nicholsoni,** (3) *D.* **euodus,** (4) *D. indentus* var. **nanus,** (5) *D.* **furcillatus,** (6) *Tetragraptus* **Halli** (= *T. serra*), (7) *T.* **Hicksii** (*Azygograptus*), **Clematograptus** n.g., (8) *C.* **implicatus,** (9) *Climacograptus* **cœlatus,** (10) *C.* **confertus,** (11) *Phyllograptus* **stella** (= *Didymog. gibberulus*), (12) *Trigonograptus* **truncatus,** (13) *Ptilograptus* **cristula,** (14) *P.* **Hicksii,** (15) *P.* **acutus,** (16) *Dendrograptus* **persculptus,** (17) *D.* **arbuscula,** (18) *D.* **Ramsayi,** (19) *D.* **serpens,** (20) *D.* **flexuosus** var. **recurvus,** (21) *Callograptus* **radiatus,** (22) *C.* **radicans,** (23) *Dictyograptus* **Homfrayi, Desmograptus** n.g., (24) *D.* **cancellatus.**

Other species described and figured are: (25) *Didymograptus affinis*, (26) *D. extensus*, (27) *D. indentus*, (28) *D. patulus*, (29) *D. Murchisoni*, (30) *D. pennatulus*, (31) *Tetragraptus quadribrachiatus*, (32) *T. serra*, (33) *Nemagraptus capillaris*, (34) *Dicellograptus moffatensis*, (35) *Diplograptus dentatus*, (36) *D. foliaceus*, (37) *D. tricornis*, (38) *Glossograptus ciliatus*, (39) *Trigonograptus ensiformis*, (40) *Dendrograptus diffusus*, (41) *D. divergens*, (42) *D. flexuosus*, (43) *Callograptus elegans*, (44) *C. Salteri*, (45) *Dictyograptus irregularis*.

Range and Distribution.—The range and distribution of these species are discussed. The division of the Arenig as proposed by Hicks into Lower, Middle, and Upper is adopted, and the Arenig and Llandeilo beds are compared as respects their Graptolites with their American and British equivalents.

1875.
Tromelin et Lebesconte,
"Essai d'un Catalogue Raisonné des Fossiles Siluriens," etc., 'Assoç. Franc. pour l'avancement des Sciences.'

From the "Schistes ardoisiers" Tromelin and Lebesconte record *Didymograpsus Murchisoni*, *Gr. Hisingeri*, and *Gr. Sedgwicki*. In the lowest part of the third fauna, namely the zone of ampelites and phtanites of Anjou and Lower Loire, they recognise *Gr. colonus*, *Gr. Becki*, *Gr. Nilssoni*, *Gr. spiralis*, and *Diplo. folium*, while from the upper zone or "ampelite nodules" *Gr. Bohemicus*, *Gr. Becki*, and *Gr. priodon* are recorded.

1876.
Linnarsson,
"On the Vertical Range of Graptolites in Sweden," 'Geol. Mag.,' dec. 2, vol. iii.

In a valuable paper "On the Vertical Range of the Graptolites in Sweden," Linnarsson showed that Graptolites occur on at least six distinct horizons in the Cambrian and Silurian rocks of Norway and Sweden each horizon being marked by different forms, and he satisfactorily parallels them with known horizons in Britain: (1) the Olenus Shales with the Upper Dolgelly of North Wales; (2) the Dictyonema Shales with the Dictyonema-bearing beds in Britain and the Baltic provinces; (3) the Lower Graptolitic Shales with the Skiddaw and Quebec groups; (4) the Middle Graptolitic Shales with the Moffat series; (5) the Upper Graptolitic Shales with the Coniston and Gala beds; (6) the Higher Silurian with the Wenlock and Ludlow.

1876.
Nicholson,
"Notes on the Correlation of the Graptolitic Deposits of Sweden with those of Britain," 'Geol. Mag.,' dec. 2, vol. iii.

A general review of Linnarsson's paper, by Nicholson, accompanied it. In addition to discussing the various British strata corresponding to Linnarsson's five Swedish zones, Nicholson gives diagnoses and figures of four new genera from the Skiddaw Slates, previously included by him under the single genus *Dichograptus*. These are (*a*) **Trichograptus**, type *T. fragilis*; (*b*) **Temnograptus**, *T. multiplex;* (*c*) **Schizograptus**, *S. reticulatus;* (*d*) **Ctenograptus**, *C. annulatus*.

1876.
M'Coy,
"On a new Victorian Graptolite," 'Ann. Mag. Nat. Hist.,' ser. 4, vol. xviii.

A new species of Graptolite was described and figured by M'Coy from the Bendigo beds of Victoria, under the name *Didymograpsus* **Thureaui**, but he suggests that, if the genus *Didymograpsus* is to be restricted to the two-branched forms, this species should be made the type of a new genus—**Goniograptus**.

1876.
Törnquist,
"Nyblottad profil med *Phyllograptus* skiffer i Dalarne," 'Geol. Fören. i Stock. Förh.,' no. 36, bd. 3, no. 8.

A short stratigraphical paper appeared this year by Törnquist, on the Phyllograptus shales of Dalarne and their fossils.

1876.
Lapworth,
"On Scottish Monograptidæ," 'Geol. Mag.,' dec. 2, vol. iii.

In 1876 Lapworth described in detail the various species of Scottish Monograptidæ, revising the synonymy and classification, and figuring the species, many of which were new.

Synonymy.—Four genera are included in the family of the Monograptidæ, *Monograptus*, *Cyrtograptus*, and *Rastrites*, and a new genus **Dimorphograptus**. The author discusses at some length the respective merits of the generic names *Graptolithus*, *Monoprion*, and *Monograptus*, for those unilateral Graptoloidea in which the thecæ are in contact with one another, and decides in favour of *Monograptus*. He retains the genus *Rastrites*, and notes the presence of the virgula in this genus.

Development.—The development of the Monograptidæ is here stated to be similar to that of the bilateral Graptoloidea, but "the polypary originates from a point near the broad end of the sicula," and "grows backward along the distal portion of the sicula itself, to which it adheres." He considers it "probable that all the Graptoloidea ought to be regarded as colonies of siculæ, held together by a common body."

Description of Species.—The following species are described and figured, and the localities and ranges of each are given.

Genus *Rastrites.*—(1) *R. peregrinus*, (2) *R. capillaris*, (3) *R. maximus*, (4) *R.* **distans**, (5) *R. peregrinus* var. **hybridus**.

Genus *Monograptus :*

Group I.—Type *M. Nilssoni.* (6) *M. Nilssoni*, (7) *M. intermedius*, and (8) var. **involutus**, (9) *M.* **gregarius**, (10) *M. attenuatus*, (11) *M. Salteri*, (12) *M.* **argutus**, (13) *M. tenuis*, (14) *M.* **Sandersoni**, (15) *M.* **concinnus**.

Group II.—Type *M. Hisingeri.* (16) *M. Hisingeri* and (17) var. **jaculum**, (18) *M.* **cyphus**, (19) *M.* **leptotheca**, (20) *M. vomerinus.*

Group III.—Type *M. Halli.* (21) *M. Halli*, (22) *M.* **Riccartonensis**, (23) *M.* **galaensis**, (24) *M. priodon*, (25) *M. Flemingii*, (26) *M. colonus*, (27) var. *dubius.*

Group IV.—Type *M. Sedgwickii.* (28) *M. Sedgwickii*, (29) *M. convolutus*, (30) var. (*a*) **communis**, (31) (*b*) *fimbriatus*, (32) (*c*) *proteus*, (33) (*d*) *spiralis*, (34) *M. triangulatus*, (35) *M. turriculatus.*

Group V.—Type *M. lobiferus.* (36) *M. lobiferus*, (37) *M. Becki*, (38) *M. Clingani*, (39) *M.* **runcinatus**, (40) *M. Barrandei*, (41) *M. exiguus*, (42) *M.* **crispus**.

Genus *Cyrtograptus.*—(43) *C.* **Carruthersi**, (44) *C.* **Grayi**.

Genus *Dimorphograptus.*—(45) *D.* **elongatus** and (46) *D.* **Swanstoni**.

The discovery of the genus *Dimorphograptus*, intermediate between *Monograptus* and *Diplograptus*, led Lapworth to abandon his former theory that in *Diplograptus*, etc., the sicula gave origin to two buds, and to suggest a simpler one. "According to this new theory the sicula in *all* the Graptoloidea throws off a single bud

only, and this theoretically invariably originates a single cœnosarcal tube." In *Diplograptus*, *Pleurograptus*, etc., this is divided immediately after origin; but in *Tetragraptus* division takes place twice. The horizontal bar between the proximal ends of the two pairs of primary branches in *Tetragraptus*, etc., is Hall's true "funicle," and is the only non-polypiferous portion of the polypary.

Lapworth considers that the structure of *Dimorphograptus* "lends support to the theory that the Monograptidæ are the direct descendants of the Diplograptidæ, and not of any of the compound monoprionidian genera."

Range and Distribution.—The paper concludes with a general account of the range and distribution of the Monograptidæ in Britain and abroad. The author recognises three successive specific groups, viz., those of the (1) Birkhill Shales (= Coniston Mudstones = Lower Llandovery), (2) Gala and Girvan, (3) Upper Silurian of Riccarton and the Pentland Hills (= Coniston Flagstones and Wenlock and Ludlow Beds). Each of these possesses a well-marked and distinctive assemblage of Monograptidæ, and the vertical distribution of species in Scotland is in complete agreement with that in England, Ireland, and Europe.

He emphasises the fact that not a single species of any genus of the Monograptidæ occurs in beds lower than the Bala limestone and therefore that the family is exclusively a Middle and Upper Silurian one.

1876.
Lapworth,
'Catalogue of Western Scottish Fossils.'
"*Graptolites.*"

A complete illustrated list of the Scottish Graptolites recognised in 1876 was given by Lapworth in the 'Catalogue of Western Scottish Fossils' prepared for the Meeting of the British Association at Glasgow. Among them were several new species which were figured but not described. It will suffice here to mention the figured forms then new to science: (1) *Diplograptus pristis* var. **truncatus,** (2) *D. foliaceus* var. **calcaratus,** (3) *D.* **perexcavatus,** (4) *D. quadrimucronatus* var. **spinigerus,** (5) *D.* **aculeatus,** (6) *Climacograptus* **tubuliferus,** (7) *C. bicornis* var. **tridentatus** and (8) var. **peltifer,** (9) *C.* **Scharenbergi,** (10) *C.* **cœlatus,** (11) *Cænograptus* **nitidulus,** (12) *C.* **pertenuis,** (13) *C.* **explanatus,** (14) *Amphigraptus* **radiatus,** (15) *Didymograptus* **superstes,** (16) *Dicranograptus* **ziczac** and (17) var. **minimus,** (18) *Dicellograptus* **pumilus,** (19) *D.* **caduceus,** (20) *D. Forchammeri* var. **articulatus** and (21) var. **flexuosus,** (22) *Corynoides* **curtus,** (23) *Thamnograptus* **scoticus,** and (24) *Dictyograptus* **moffatensis.**

1874–6.
Dairon,
"Notes on the Silurian Rocks of Dumfriesshire and their Fossil Remains," 'Trans. Geol. Soc. Glasgow.'

Two papers on the Silurian rocks of Dumfriesshire and their fossil remains were read by Dairon before the Geological Society of Glasgow in 1874—1876. In these a general account of the Graptolites is given, their affinities, structure, development, etc. A number of species are given and figured, and three new ones are figured but not described: (1) *Thamnograptus* **crucifer,** (2) *Retiolites* **branchiatus,** and (3) *Dicellog.* **guilloche.**

1876.
Swanston & Lapworth, "On the Silurian Rocks of Co. Down, with Appendix," 'Proc. Belf. Nat. Field Club.'

The results of the researches of Swanston among the Graptolite-bearing Silurian rocks of co. Down, together with a list of the Graptolites that they afford, were published in 1876—1877. Many new localities for Graptolites in Ireland are given, and the existence of the representatives of the Glenkiln shales, Lower and Upper Hartfell, Lower and Upper Birkhill (with the exception of the *Rastrites maximus* zone), and the Gala beds is proved.

To Swanston's paper there is an Appendix by Lapworth in which he figures and describes, mainly from his own collections, a large number of the species common to Ireland and Scotland. The majority of these were forms already named, while a few new forms are described in addition. (Those marked S.F. below had already been figured by Lapworth in his 'Catalogue of Western Scottish Fossils,' and are here described for the first time.) The list includes: (1) *Rastrites peregrinus*, (2) var. *hybridus*, (3) *Monograptus triangulatus*, (4) *M. spiralis*, (5) var. *fimbriatus*, (6) var. *communis*, (7) var. *proteus ?*, (8) *M. Sedgwicki*, (9) *M. turriculatus*, (10) *M. crispus*, (11) *M. exiguus*, (12) *M. Barrandei*, (13) *M. runcinatus*, (14) *M. lobiferus*, (15) var. **pandus,** (16) *M. priodon*, (17) *M. riccartonensis*, (18) *M. galaensis*, (19) *M.* **M'Coyi,** (20) *M. Hisingeri* var. *jaculum*, (21) *M. cyphus*, (22) *M. leptotheca*, (23) *M. concinnus*, (24) *M. gregarius*, (25) *M. argutus*, (26) *M. Sandersoni*, (27) *M. tenuis*, (28) *M. attenuatus*.

Dimorphograptus.—(29) *D. Swanstoni*, (30) *D. elongatus*.

Cephalograptus.—(31) *C. cometa*.

Diplograptus (in the sub-genus *Glyptograptus* (*G. tamariscus*) Lapworth believes that there is no vertical septum, the cœnosarcal tube being apparently undivided).—(32) *D. acuminatus*, (33) *D. modestus* (S. F.), (34) *D. sinuatus*, (35) *D. tricornis*, (36) *D. angustifolius*, (37) *D. tamariscus*, (38) *D. dentatus*, (39) *D. Hughesi*, (40) *D. insectiformis*, (41) *D. folium*, (42) *D. truncatus*, (43) *D. foliaceus*, (44) *D. vesiculosus*, (45) *D. quadrimucronatus*, (46) *D. Whitfieldi*, (47) *D.* (*Lasiograptus?*) *mucronatus*, (48) *D.* (*Hallograptus*) *bimucronatus*.

Glossograptus.—(49) *G. Hincksii*.

Lasiograptus.—(50) *L.* **margaritatus**, (51) *L. Harknessi*.

Clathrograptus.—(52) *C. cuneiformis* (S. F.).

Retiolites.—(53) *R.* **fibratus** (54) *R. perlatus ?* (55) *var.* **Daironi** (56) *var. obesus*.

Climacograptus.—*C. scalaris*, var. *tectus*, (56) *var.* **normalis** (57) *var. rectangularis*, (58) *var.* **caudatus**, (59) *var. tubuliferus* (S.F.), (60) *C. Scharenbergi* (S.F.), (61) *C. bicornis*, (62) var. *tridentatus* (S.F.), (63) *var. peltifer* (S.F.), (64) *C. cælatus*, (65) *C. Wilsoni* (S.F.), (66) *C. perexcavatus* (S.F.), (67) *C. innotatus*.

Dicranograptus.—(68) *D. ramosus*, (69) *D. Nicholsoni*, (70) *D. formosus*, (71) *D. clingani*, (72) *D. ziczac* (S.F.), (73) var. *minimus* (S.F.).

Dicellograptus.—(74) *D. elegans*, (75) *D. Forchammeri*, (76) *D. moffatensis*, (77) var. *divaricatus*, (78) *D. caduceus* (S.F.).

Didymograptus.—(79) *D. superstes* (S.F.)

Leptograptus.—(80) *L. flaccidus.*

Cœnograptus.—(81) *C. gracilis*, (82) *C. surcularis*, (83) *C. pertenuis* (S.F.).

Thamnograptus.—(84) *T. typus ?*

Dictyonema.—(85) *D. moffatensis* (S.F.).

1877. *Linnarsson*, "Om Graptolitskiffern vid Kongslena i Vestergötland," 'Geol. Fören. Förh.,' no. 41, bd. 3.

In 1877 Linnarsson recorded the presence of a large number of species of Graptolites in the "*Lobiferus* shales" at Kongslena, in Vestergötland. He only gives the names of those already described, but mentions that there are others, probably new.

He discusses at considerable length the probable equivalents of these beds in Great Britain, Bohemia, etc.

1878. *Haupt*, "Die Fauna des Graptolithengesteines," 'Neues Lausitzisches Mag.' bd. 54.

Some addition to our knowledge of the fauna of the "Graptolithengestein" of North Germany was made by Haupt in 1878. He records 14 Graptolites, and the majority are described and figured. One genus and species is new. He describes, but gives no figures of, *Monograpsus priodon*, *M. bohemicus*, *M. colonus* and *M. sagittarius*. He describes and figures (1) *M. distans ?* (= *M. scanicus* Tullb.), (2) *M. Salteri* ? Gein., (3) *M. Nilssoni*, (4) *M. proteus ?* (5) M. sp. 1, and (6) sp. 2, (unidentifiable), (7) *M. turriculatus*, (8) *Rastrites* sp., (9) *Dendrograpsus* sp. (10) **Quadruplograpsus rhomboidalis** is the name given by him to a form which he supposes to have four rows of cells. (The identity of this form is dubious, and it would seem that the four-rowed character is only apparent, not real.)

From other isolated blocks in the Drift he figures the new forms (11) *Retiolites* **gracilis**, (12) *Retiolites* sp., (both Diplograptid, probably of the amplexicaul type) and (13) *Diplograpsus* sp. (which resembles *Cryptograptus*).

1878. *M'Coy*, 'Prodromus of the Palæontology of Victoria,' dec. 5.

The fifth part of M'Coy's 'Prodromus' appeared in 1878. Good specimens of *Didymograptus* (*Goniograptus*) *Thureaui* are figured, and one of *Didymograptus* (*Tetragraptus*) *Headi*.

1878. *Lapworth*, "The Moffat Series," 'Quart. Journ. Geol. Soc.,' vol. xxxiv.

In this year Lapworth published a paper on the "Moffat Series of South Scotland." In this memoir the species of Graptolites are for the first time employed throughout in the grouping and correlation of the stratigraphical subdivisions; and the conclusion is drawn that this Moffat Series, which is only some 300 feet in collective thickness in the typical area,

embraces three formations—the Glenkiln, Hartfell, and Birkhill—answering respectively to the Upper Llandeilo, Bala, and Lower Llandovery formations of Southern Britain and is separable into at least eleven Graptolitic zones.

1878. *Gümbel*, "Einige Bemerkungen über Graptolithen," 'Neues Jahrb.,' 1878.

An attempt to study the minute structure of Graptolites by means of dissolving away the calcareous matrix, and thus isolating the Graptolite, was made in 1878 by Gümbel. The experiments were made with specimens of *M. priodon*, and accurate drawings of some of the cells, both in relief and in section, are given in his paper. Gümbel notices particularly the thickening of the cell-wall in three places—(1) at its proximal end, (2) at the point of junction with the cell-wall next above, and (3) at the edge of the aperture.

As a result of his tests he believes that the skeleton is formed of a "structureless, membranous substance, consisting of several thin layers," like the chitinous skeleton of the Sertularia.

He records the existence of two distinct Graptolite horizons in the Fichtelgebirge. He notes the discovery of *Cyrtograptus ? Murchisoni* and *Pleurograptus* cfr. *linearis*, from the Upper Graptolite shales.

1878. *Richter*, "Notize über die Graptoliten d. H. Gümbels," 'Neues Jahrb.'

Gümbel's paper was briefly referred to and criticised by Richter in another number of the 'Neues Jahrbuch' for the same year, and his conclusions are in the main accepted.

1878. *Kayser*, "Die ältesten Devon. Ablagerungen des Harzes," 'Abhandl. zur geol. Specialkarte v. Preussen u. d. Thüringischen Staaten, bd. 2, heft 4.

In this year also, Kayser described and figured all the Graptolite forms hitherto recorded from the Harz Mountains from the beds lying at the top of the so-called "Untere Wieder Schiefer," and below the Haupt Quartzite. These Graptolite-bearing beds he still considered to be of Lower Devonian age. The forms figured are only fragmentary, but they appear to be correctly identified on the whole; they include: (1) *M. Nilssoni*, (2) *M. convolutus*, (3) *M. Halli*, (4), *M. colonus*, (5) *M. dubius*, (6) *M. sagittarius*, and (7) *M. jaculum ?* He considers that *M. dubius* is identical with Roemer's species *M. Jüngsti*, *M. polydonta*, *M. obliquo-truncatus*, and *M. subdentatus* (pars).

1878–1879. *Spencer*, "Graptolites of the Niagara formation," 'Canadian Naturalist.'

A large number of genera and species of the Dendroidea are described by Spencer, from the Niagara formation. No figures are given.

The new genera are **Calyptograpsus, Rhizograpsus, Acanthograpsus**. The new species are *Calyptograpsus* **cyathiformis**, *C.* **subretiformis**, *Rhizograpsus* **bulbosus**, *Dictyonema* **tenella**, *Acan-*

thograpsus **Granti,** *Ptilograpsus* **foliaceus,** *Thamnograpsus* **bartonensis,** and *Callograpsus* **niagarensis.**

1879. *Linnarsson,* "Jakttagelser öfver de graptolitförande skiffrarne i Skåne," 'Geol. Fören. Förh.,' no. 50, bd. 4.

In 1879 Linnarsson described the various graptolite horizons of Sweden, and compared them with those of Great Britain and elsewhere. He recognises three main divisions: (1) the Lower, (2) the Middle, and (3) Upper Graptolite shales, corresponding in the main to (1) Arenig, (2) Llandeilo-Hartfell, (3) Llandovery to Lower Ludlow.

1879. *Linnarsson.* "Om Gotlands Graptoliter," 'Kongl. Vetensk-Akad. Förh.,' no. 5.

In the same year Linnarsson described three species of Graptolites from the Visby and Middle Gotland Groups of the Silurian formation in Gotland. The Graptolites, though rare, are well preserved in limestone, and Linnarsson was able to give detailed descriptions of their structure, illustrated by excellent drawings.

Structure.—In his description of *Monograpsus priodon* he calls attention to the variation in form of the proximal portion of the polypary, as figured by different authors; and he inclines to the view that the straight shape is the more typical.

1879. *Zittel.* 'Handbuch der Palæontologie' (1876–80), band I.

An admirable summary and digest of the chief results of research and opinion with respect to the Graptolites to the close of the year 1878 was given by Zittel in the second part (issued in 1879) of his 'Handbuch der Palæontologie.' He assigns the Cladophora (Hopk.) to the Campanulariæ, and classes the Rhabdophora (Allmann) as a distinct sub-order of the Hydroida, but under the title of the Graptolithidæ. The structure of the polypary in the Graptolithidæ is described and illustrated; and the mode of existence and zoological position, etc., of the Graptolites in general discussed. The classification adopted agrees essentially with that of Lapworth (1873). The geological ranges of the various genera are noted, and it is shown that six main Graptolitic horizons or zones are already recognisable in Europe and North America. The text is illustrated by several good figures.

His observations on the structure of *Retiolites Geinitzianus* are somewhat indefinite, owing to the fact that he had only one specimen for examination. The chitinous network he believes to be quite superficial, and the stronger strands which mark the boundaries of the thecæ probably mere threads, not lamellæ as is the case with other Graptolites, so that the interior of the polypary is not divided up into separate thecæ. No virgula was observed by him in this Gotland specimen, and he is inclined to doubt the existence of two virgulæ as described by Barrande. A species of *Dictyonema* is also recorded by him, but is not described or figured.

1879. *Törnquist,* "Några Iakttagelser öfver Dalarnes Graptolitskiffar," 'Geol. Fören. Förh.,' bd. iv, no. 4.

A paper by Törnquist on the Graptolite shales of Dalarne is mainly stratigraphical, but two new species are described and figured, *viz. Didymograptus minutus* and *Phyllograptus* **densus,** while a new variety of *Diplograptus palmeus* var. **superstes,** and one of *M. spiralis* var. **subconicus** are recorded.

In Dalarne he recognises the following graptolite horizons: 1, Phyllograptus skiffer with *Phyllograptus, Tetragraptus,* etc.; 2, Trinucleus skiffer, corresponding to the Hartfell; 3, Lobiferus skiffer, with five zones: (*a*) *M. leptotheca,* (*b*) *Diplo. cometa,* (*c*) *M. Sedgwickii,* (*d*) *M. turriculatus,* (*e*) *M. priodon* and *D. palmeus* var. *superstes*; and 4, Retiolites skiffer with *Ret. Geinitzianus* and *M. spiralis* var. *subconicus.*

1879—1881. *Quenstedt,* 'Petrefactenkunde Deutschlands,' bd. vi, Graptolithi.

In his text-book of fossils Quenstedt gives a general account of the Graptolites, and figures of many forms, but the majority of these are copies from earlier authors. He classes the Graptolites among the corals, between the "Rind" corals and the Bryozoa, and retains the old nomenclature.

Description of Species.—(1) *Dictyonema flabelliforme* he describes under the old name of *Gorgonia.* His figures of (2) *Graptolithus serratus* include forms of the group *M. colonus,* etc. His (3) *Gr. ludensis* includes *M. priodon* and *M. testis,* his (4) *Gr. colonus* = *M. Roemeri, M. dubius, Didymo. pennatulus* and *D. Murchisoni,* his (5) *Gr. scalaris* embraces *M. Nilssoni, M. bohemicus,* etc.

The Didymograpti noticed by him include *Tetragraptus,* and all the allied branched forms, together with *Dendrograptus,* while *Diplograptus* and *Climacograptus,* etc., are classed as *Digrapti.*

1880. *Lapworth,* "On new British Graptolites," 'Ann. Mag. Nat. Hist.,' ser. 5, vol. v.

In 1880 Lapworth described and figured a number of new British species of Graptolites, revised a few forms already recognised but of which little was known, and he suggested some new generic and sub-generic names. The species figured include the following: (1) *Monograptus leintwardinensis,* Hopk. MS., (2) *M. Salweyi,* Hopk. MS., (3) *M. Roemeri,* (4) *M. colonus,* (5) *M. galaensis* var. **basilicus,** (6) *M.* **crenularis,** (7) *M.* **crassus,** (8) *M. riccartonensis,* (9) *M. Flemingii,* (10) *M. Hisingeri* var. **nudus,** *M. Salteri,* (11) *Cyrtograptus* **Linnarssoni,** (12) *Azygograptus* **cœlebs,** (13) *Dicellograptus* **complanatus,** (14) *Dicello.* **intortus,** (15) *Dicello.* **patulosus,** (16) *Dicello. divaricatus* var. **rigidus.** The new genus **Bryograptus** is founded, and two new species described belonging to this genus, viz. (17) *Bryo.* **Kjerulfi** and (18) *Bryo.* **Callavei.**

Under *Diplograptus* he describes Nicholson's (19) *D. physophora,* (20) *D.* **socialis,** nov. d., (21) *D.* **(Glyptograptus) euglyphus,** (22) *D. perexcavatus, D. rugosus, Emm*? (23) *Climacog.* **confertus.**

He proposes the new sub-generic name **Idiograptus** for forms typified by (24) *D.* **aculeatus.**

The peculiar structure presented by the curious forms (25) *D. tricornis*, *D. marcidus*, and *D. Etheridgii* is described and explained, the new generic title **Cryptograptus** is suggested for them, and a new variety (26) var. **Schäferi** is figured.

A new species of *Lasiograptus*, (27) *L.* **retusus** is figured and described.

1880. *Marr.* "On the Pre-Devonian Rocks of Bohemia," 'Quart. Journ. Geol. Soc.,' vol. xxxvi.

In a paper giving the results of his personal researches among the Pre-Devonian Rocks of Bohemia, Marr shows that the Band E. *e.* 1 of Barrande includes three distinct Graptolitic zones (1, *Diplograptus* zone; 2, *priodon* zone; 3, *colonus* zone), and that the same three zones occur in the so-called "colonies" in the same order, thus affording "grounds for the supposition that these are only portions of the Band E. *e.* 1 faulted down among the grits and shales at the summit of the Cambrian (Ordovician) Series."

1879–1880. *Lapworth,* "On the Geological Distribution of the Rhabdophora," 'Ann. and Mag. of Nat. Hist.,' ser. 5, vols. iii, iv, v, and vi.

During the years 1879—1880 appeared Lapworth's paper "On the Geological Distribution of the Rhabdophora," which was published in parts in the 'Annals and Magazine of Natural History.'

This memoir is devoted to an exhaustive examination and discussion of the available facts bearing upon the distribution and vertical range of all the known Graptolite species in Britain and abroad, with a view of correcting the prevalent neglect of these fossils by geologists in general and of showing their importance as constituting probably the most reliable chronological indices available in working out the detailed stratigraphy of the Lower Palæozoic formations.

Part I.—*Historical.*—In the introductory part Lapworth points out and illustrates the geological and palæontological difficulties which had caused these fossils to fall into disrepute, enters into a critical discussion of previous opinions, and summarises the latest views upon the subject.

Part II.—*Data.*—The second part of the work is devoted to the fixation of the actual localities and horizons in Britain and abroad from which known species of Graptolites had been obtained, so far as could be gathered from previous publications and personal researches, and the special association of forms is given in each case.

Part III.—*Results.*—In the third part the results deducible from the foregoing data are discussed and tabulated both from the stratigraphical and the palæontographical points of view. In the geological section the fauna of each Graptolite-bearing formation is fixed, and in the palæontological section each Graptolite family is dealt with and the ranges of the component genera and species deduced and shown in illustrative Tables.

Part IV.—*Conclusions.*—In the fourth part Lapworth points out that strati-

graphically and morphologically the Graptolites arrange themselves into four groups:

(1) Monograpta (including the family of the Monograptidæ only).

(2) Diplograpta (including the families of the Diplograptidæ, Lasiograptidæ, and Retiolitidæ).

(3) Didymograpta (including the Dichograptidæ and Phyllograptidæ).

(4) Dicellograpta (including the Dicranograptidæ and Leptograptidæ).

He gives a table showing the Vertical Distribution of the component genera, and he considers the following propositions as established:

(1) "The Rhabdophora, or true Graptolites, are exclusively Lower Palæozoic fossils, coming into visible existence in the Upper Cambrian, and disappearing from sight in the Upper Silurian."

(2) "They attain their maximum, both in genera and species, about the middle of this range, *i. e.*, in the Llandeilo formation; and there is a gradual decrease in forms in proportion as we pass upwards or downwards from this horizon."

(3) "The three grand groups of the Didymograpta, Dicellograpta, and Monograpta are so restricted in their vertical range that each distinguishes a certain portion of the ascending succession of formations. The Didymograpta are essentially Lower Ordovician fossils, the Dicellograpta Upper Ordovician, while the Monograpta are confined exclusively to the Silurian proper."

(4) "With but two exceptions, each of the families of the Rhabdophora ranges through a fraction only of the entire succession of the Lower Palæozoic rocks, nowhere exceeding in vertical extent that of an entire system. The Dichograptidæ are Upper Cambrian and Lower Ordovician fossils; the Phyllograptidæ are exclusively Arenig; the Leptograptidæ and Dicranograptidæ are essentially Upper Ordovician; while the Lasiograptidæ are as rigidly confined to the Ordovician itself as the Monograptidæ are to the succeeding Silurian."

(5) "Among the genera this limitation in time is carried out even more minutely. *Loganograptus*, *Tetragraptus*, *Dichograptus*, *Retiograptus*, and several others are exclusively Arenig genera. *Pleurograptus*, *Amphigraptus*, *Cœnograptus*, etc., are peculiar to the Bala. *Rastrites* distinguishes the Valentian, and *Cyrtograptus* the Salopian."

(6) "Descending to the species of the Rhabdophora, we find that they are so restricted in vertical distribution that few have a more extended range than that which is covered by a single formation in the vertical series; while the vast majority are peculiar to a single sub-formation, or mark certain special horizons outside of which they are unknown. The forms which have the greatest longevity present us with the greatest number of recognisable varieties, while the species of shorter range rarely show any notable departure from the primitive type."

(7) "The ascertained restriction of the divisions, families, and genera of the

Family DIPLOGRAPTIDÆ, *Lapworth.*

1873. *Diplograptidæ,* Lapworth, Geol. Mag., vol. x, table i, p. 555.

Biserial Graptoloidea, with straight stipes.

Thecæ tubular, usually in contact for a considerable fraction of their length; ventral wall approximately straight or with every degree of sigmoid curvature; apertural margins horizontal or inclined, everted or introverted, occasionally introtorted. Test continuous, membranous.

The mode of development of the polypary in the Diplograptidæ is in the main similar to that which obtains in the biserial portion of *Dicranograptus,* and may be described as follows:

The first theca (th. 1^1) buds directly from the sicula and on the same side of it as the virgella; it grows steadily in a downward direction until it has first reached the level of the aperture of the sicula, when it bends round, and grows upward and outward. Before making this change in the direction of growth—indeed, probably soon after it has left the sicula—it gives origin to the second theca (th. 1^2) which crosses the sicula and grows in such a manner that its aperture is on the opposite side of the sicula with respect to that of the first. This second theca (th. 1^2) in turn gives rise to a third (th. 2^1) whose aperture is vertically above that of the first, and the third in its turn gives origin to a fourth (th. 2^2) whose aperture is situated vertically above that of the second. The thecæ lying on the same side of the polypary as th. 1^1 constitute the *primary series* (th. 1^1, 2^1, 3^1, etc.), those on the same side as the th. 1^2 constitute the *secondary series* (th. 1^2, 2^2, 3^2, etc.).

In some Diplograptidæ this *alternate* mode of development may persist as long as the polypary continues to grow; and in these forms, although the upper portion of each theca is individualised, the lower portions of all the thecæ communicate freely with each other. In many forms, however, the polypary is known to be divided partially or entirely by a longitudinal *septum*; in such cases the third theca (th. 2^1), (or more exceptionally a later one,) gives rise to two thecæ, one (th. 2^2) on the same side as the second (th. 1^2), and one (th. 3^1) on its own side, and these two are separated from each other by a septal wall. This septal wall may extend completely through the polypary from the obverse to the reverse side even from the earliest stages; the septum is then said to be *complete* (*Cl. scalaris.*). In other cases, however, it appears only on one side (the obverse), and is not visible on the reverse until a later stage in the growth of the polypary; the septum is then said to be *incomplete* (*Cl. medius, Cl. Törnquisti*).

Every theca developed after the commencement of the septum buds from the theca next below it belonging to its own series.

As in *Dicranograptus,* the crossing canal, as such, in the Diplograptidæ is so far reduced as to be practically non-existent.

In the Diplograptidæ the protection of the sicula is more perfectly attained than in any other family, since it is often completely imbedded in the proximal part of the polypary.

The forms belonging to the family are generally preserved as thin films, having been compressed in such a way as to show the polypary and its two lateral series of thecæ all flattened down together to their common median plane. As a consequence the diagnostic criteria primarily employed or implied in the description of the various genera and species are those detailed appearances which are presented under these special conditions in this normal aspect (*profile view*). In the progress of research these conventional criteria become supplemented, interpreted, or modified by information furnished by flattened examples presenting the ventral aspect (*scalariform view*), or by specimens preserved in the round (*in relief*), etc.

The best known genera of the family are *Climacograptus* and *Diplograptus*.

In the genus *Climacograptus* the ventral wall of the theca in the profile view shows sigmoid curvature, its free outer portion is approximately vertical, and the margins of the aperture, which is situated within a well-defined "excavation," are horizontal or but slightly inclined, though sometimes introverted, and occasionally introtorted.

In the genus *Diplograptus* the ventral wall of the theca in the profile view is approximately straight or gradually curved throughout, and is distinctly inclined, while the margins of the aperture are typically everted.

Genus **CLIMACOGRAPTUS**, *Hall.*

1865. *Climacograptus*, Hall, Grapt. of Quebec Group, p. 111.

Polypary bilaterally symmetrical, biserial throughout.

Thecæ tubular, ventral walls with every degree of sigmoid curvature; apertural margins typically horizontal, situated within well-defined "excavations," occasionally introverted and rarely introtorted.

Fig. 116.—*Climacograptus Scharenbergi*, Lapw.

Typical species of the genus *Climacograptus*, showing sigmoid curve of the ventral wall, its vertical free edge, the septal groove, etc. Dobb's Linn. Lower Hartfell Shales. Coll. Lapworth.

The polypary in *Climacograptus* varies greatly. In some forms it is characteristically minute, while in others it attains great dimensions. In some species the polypary has sub-parallel margins and attains its maximum breadth quickly, while in others again it shows marked tapering.

The sicula is never visible for its entire length in adult specimens, being more or less completely concealed by the bases of the earlier thecæ.

The mode of development of the polypary in the genus is that characteristic of the Diplograptidæ in general.

FIG. 117.—*Climacograptus Wilsoni*, Lapw.

Climacograptus whose thecæ tend to approximate in form to those of a *Diplograptus*. Specimen shows sicula and development of theca 1[1], etc. Dobb's Linn, Lower Hartfell Shales. Coll. Wood.

The ventral wall of the theca shows every degree of sigmoid curvature. In the more typical forms of the genus the upper portion of the ventral wall, when seen in profile, is approximately vertical and free (free edge), the middle portion (impressed edge) curves sharply inwards to form the so-called excavation, while the lower portion (edge of contact) resumes the vertical position and is in contact with the theca next below (see Fig. 116).

In the less typical species the distal free edge becomes more inclined, the excavation shallower and less abrupt, and the whole ventral wall forms a more flattened curve and points in the direction of *Diplograptus* (see Fig. 117).

The apertural margin in *Climacograptus* is typically horizontal, but it may be introverted and in exceptional cases introtorted.

The thecal spines are ventral and mesial in position, as in the Dicranograptidæ.

The *Climacograpti* may be grouped as follows:

I.—*Climacograpti* in which the free edge of the ventral wall is approximately straight and vertical, and the apertural margin horizontal.

Type *Climacog. scalaris.*

- *Cl. scalaris.*
  - var. *normalis.*
  - var. *miserabilis.*
- *Cl. rectangularis.*
- *Cl. medius.*
- *Cl. Törnquisti.*
- *Cl. minimus.*
- *Cl. brevis.*
- *Cl. bicornis.*
  - var. *tridentatus.*
  - var. *peltifer.*
- *Cl. supernus.*
- *Cl. Wilsoni.*
  - var. *tubularis.*

II.—*Climacograpti* in which the free edge is slightly inclined, and the apertural margin is somewhat introverted.

Type *Climacog. antiquus.*

- var. *lineatus.*
- var. *bursifer.*
- *Cl. caudatus.*
- *Cl. tubuliferus.*
- *Cl. latus.*
- *Cl. styloideus.*

III.—*Climacograpti* in which the free edge is practically straight and vertical, and the apertural margin is slightly introverted and introtorted.

Type *Climacog. Scharenbergi.*
Cl. Scharenbergi.
Cl. Hughesi.
Cl. minutus.
Cl. extremus.

IV.—*Climacograpti* in which the straight and vertical free edge is provided with a mesial spine, and the apertural margin tends to be slightly everted.

Type *Climacog. innotatus.*
Cl. innotatus.

V.—*Climacograpti* in which the free edge is slightly inclined, and the apertural margin is thickened and spined.

Type *Climacog. tuberculatus.*
Cl. tuberculatus.

Group I.

Climacograpti in which the free edge of the ventral wall of the theca is approximately straight and vertical, and the apertural margin horizontal.

Climacograptus scalaris (Hisinger) (Linné ?). Plate XXVI, figs. 1 *a—c*.

1821. *Orthoceratites tenuis*, Wahlenberg, Petrifacta Tell. Suec., Nova Acta Reg. Soc. Scient. Upsala, vol. viii, p. 93.
1837. *Prionotus scalaris*, Hisinger, Lethea Suecica, Suppl. p. 113, pl. xxxv, fig. 4.
1867. Non *Climacograptus scalaris*, Carruthers, Intell. Obs., p. 370, pl. ii, fig. 6.
1881. *Climacograptus scalaris*, Tullberg, Bihang. till k. Vet.-Akad. Handl., vol. vi, p. 9, pl. i, figs. 12—14.
1890. *Climacograptus scalaris*, Törnquist, Siljansomr. Grap., I. Acta Univ. Lund, vol. xxvi, p. 23, pl. 11, figs. 12—15.
1893. *Climacograptus scalaris*, Törnquist, Struct. Diprionidæ, Acta Univ. Lund, vol. xxix, p. 2, figs. 1—22.
1897. *Climacograptus scalaris*, Törnquist, Diplog. and Heteropr. of Scanian Rastrites Beds, Acta Reg. Soc. Physiog. Lund, vol. viii, p. 6, pl. i, figs. 1—8.

Polypary not exceeding 2 cm. in length; having an average breadth of 1·5 mm., sicula 0·6 mm. in length.[1] Virgella conspicuous but short. Thecæ eleven to nine in 10 mm., having a length of 1·5 mm., overlapping one-third of their length, free outer edges straight and vertical; apertural margin horizontal, lying within approximately semicircular or sub-elliptical excavations which occupy one-quarter of the width of the polypary and one-fourth to one-third of its ventral margin. Septum complete.

Figs. 118 *a* and *b*.—*Climacograptus scalaris* (His.).

a. *b*.

a. Complete specimen, nat. size, from Hisinger's type locality of Mösseberg, Vestrogothia. Coll. Dr. J. E. Marr.
b. Enlargement (× 5) of the proximal end.

Description.—The polypary is characteristically small and the breadth is attained by somewhat rapid

[1] The visible length is given in each case.

widening from the proximal end, so that the margins are sub-parallel for the greater part of their extent.

The short, robust virgella is always conspicuous, and usually measures about 1 mm. in length. The sicula is almost entirely concealed by the growth of th. 1^1 and th. 1^2, so that the proximal end presents a symmetrically rounded off appearance, especially on the reverse aspect.

The septum appears to originate at once, and to be complete from the earliest stages.

The virgula is often prolonged beyond the distal end of the polypary.

Remarks.—The foregoing description has been drawn up from British specimens which agree very closely with specimens from Hisinger's typical locality. Hisinger's species has been recorded from many localities, but these identifications appear to be erroneous; the form is a rare one in Britain, and has never hitherto been figured from any locality in the British Isles; all the figured forms hitherto referred to *Cl. scalaris* belong to one or other of the varieties or species described below.

Affinities.—The characteristic features of *Cl. scalaris* (His.), are the following:

(1) Its complete septum;

(2) Its symmetrical proximal end, with a short virgella;

(3) Its small size.

Distal fragments resemble those of *Cl. rectangularis* and *Cl. medius*, but when the complete polypary is seen there are marked differences in the proximal ends. From *Cl. rectangularis*, *Cl. scalaris* differs in its lesser width and smaller size, while from *Cl. medius* it may be distinguished by its smaller size, shorter virgella, and more complete septum.

Horizon and Localities.—Upper Birkhill Shales, Lower Gala Beds and their equivalents.

S. Scotland: Dobb's Linn; Belcraig Burn; Lockerbie, etc. *Ireland:* Donaghadee; Pomeroy. *Wales:* Conway; Llanystwmdwy; R. Twymyn, etc. *Lake District:* Skelgill, etc.

Associates, etc.—*Cl. scalaris* is a rare fossil in the British Isles, though it appears to be present in small numbers wherever the Upper Birkhill Shales or their equivalents are found. It seems to occur most commonly at the base of the zone of *Monog. Sedgwicki* and to be associated with *Monog. lobiferus* and *Cephalog. petalum.* It is also met with more rarely in the Lower Gala Beds associated with *Rastrites maximus* and *Monog. turriculatus.*

Collections.—Sedgwick Museum, the Authors, etc.

Var. **normalis,** Lapworth. Plate XXVI, figs. 2 *a—g*.

1877. *Climacograptus scalaris* var. *normalis*, Lapworth, Grap. Co. Down, Proc. Belfast Nat. Field Club, p. 138, pl. vi, fig. 31.

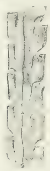
Though the typical form of *Cl. scalaris* (as described by Tullberg from Hisinger's specimens) seems to be found in Britain only in the Upper Birkhill Shales and their equivalents, a variety of it, var. *normalis*, occurs in abundance in the Lower Birkhill Shales, particularly in the Moffat country in the so-called "gingerbread" bed at their base. This variety differs chiefly from the type form in point of size, attaining often a length of about 5 cm., but never exceeding 1·5 mm. in breadth and often barely exceeding 1 mm. The margins of the polypary are usually sub-parallel for the greater part of their extent, but some individuals appear to widen more gradually than others.

FIGS. 119 *a, b, c.*—*Climacograptus scalaris*, var. *normalis*, Lapw.

a *b* *c*

a. Obverse view. Dobb's Linn, Lower Birkhill Shales (zone of *Cephalog. acuminatus*). Coll. Lapworth.
b. Reverse view. Ibid. Coll. H. Lapworth.
c. Obverse view showing part of sicula. Ibid. Coll. Lapworth.

FIG. 119 *d.* — *Climacograptus scalaris*, var. *normalis*, Lapw.



d

d. Distal thecæ showing their general form. Dobb's Linn, Lower Birkhill Shales. Coll. Lapworth.

Horizon and Localities.—Lower Birkhill Shales and highest Hartfell Shales.

S. Scotland: Dobb's Linn, Garple Linn, etc. *Wales:* Rhayader District. *Ireland:* Donaghadee, Co. Down, etc.

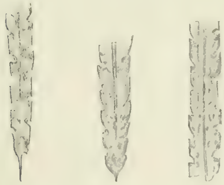
Associates, etc.—Var. *normalis* seems to make its first appearance in the *Dicellogr. anceps* zone, but it occurs most abundantly in the zone of *Cephalog. acuminatus*, where it is commonly associated with the zone fossil and *Cl. rectangularis.* Some individuals survive into the overlying zones of *Diplog. vesiculosus* where they are associated with *D. vesiculosus* and various *Dimorphograpti*; and a few continue into the zone of *Monog. gregarius.* It has never been found in the Upper Birkhill Shales.

Collections.—Lapworth and the Authors.

Var. **miserabilis**, var. nov. Plate XXVI, figs. 3 *a—h*.

A form that may be regarded as the forerunner of the *scalaris* sub-group of *Climacograpti* makes its appearance in the *Dicellograptus complanatus* zone. It is a characteristically small, uniformly narrow form, averaging 1—2 cm. in

FIGS. 120 *a—c.*—*Climacograptus scalaris* var. *miserabilis*, nov.



a. b. c.

a. Well preserved specimen, obverso view. Dobb's Linn, Upper Hartfell Shales (zone of *Dicellog. complanatus*). Coll. Wood.
b. Proximal end showing the typical aspect. Ibid. Coll. Lapworth.
c. Distal thecæ. Ibid.

length and never exceeding 1 mm. in breadth, being more commonly about ·8 mm. The thecæ are of the usual *scalaris* type, and number eleven to ten in 10 mm.

Affinities.—Var. *miserabilis* has all the appearance of a starved *Cl. scalaris*, with which species it agrees in the type of its thecæ and the general characters of the proximal end; it differs in its smaller size and width.

Horizon and Localities.—Upper Hartfell Shales and Lower Birkhill Shales.

S. Scotland: Dobb's Linn, Hartfell, etc. *Shropshire:* Aldress Burn.

Associates, etc.—Var. *miserabilis* is most abundant in the zone of *Dicellog. complanatus*, where it occurs in association with the zone fossil and *Diplog. socialis;* it is also met with in the *Dicellog. anceps* zone associated with *Dicellog. anceps*, *Cl. supernus* and *Cl. latus;* while a few individuals survive into the lowest beds of the Birkhill Shales, where they have been found associated with *Cephalog. acuminatus*, *Diplog. vesiculosus*, and various *Dimorphograpti*.

Collections.—Lapworth and the Authors.

Climacograptus rectangularis (M'Coy). Plate XXVI, figs. 5 *a—c*.

1850. *Diplograpsus rectangularis*, M'Coy, Ann. Mag. Nat. Hist., ser. 2, vol. vi, p. 271.
1851. *Diplograpsus rectangularis*, M'Coy, Brit. Pal. Foss., p. 8, pl. i, B, fig. 8.
1876. Non *Climacograptus rectangularis*, Lapworth, Cat. West Scot. Foss., pl. ii, fig. 50.
1877. Non *Climacograptus scalaris* var. *rectangularis*, Lapworth, Grap. Co. Down, Proc. Belfast Nat. Field Club, p. 138, pl. vi, fig. 32.
1897. Non *Climacograptus rectangularis*, Törnquist, Diplog. and Heteroprionidæ of Scanian Rastrites Beds, Acta Reg. Soc. Physiog. Lund, vol. viii, p. 8, pl. i, figs. 16—21.

Polypary 1—4 cm. in length, widening steadily from 1 mm. (0·5 in relief) until a maximum breadth of 2·5 mm. is attained. Sicula 1·5 mm. in length but partially concealed; virgella conspicuous, short. Thecæ of the general type of those of *Cl. scalaris*, twelve to ten in 10 mm. Septum nearly complete.

Description.—The polypary exhibits great variation in length, but the general characters are always maintained. The increase in breadth is gradual and almost imperceptible over the first 1·5 cm. of its extent; the maximum width attained varies between 2 mm. and 2·5 mm., but never exceeds the latter dimension.

The sicula has a total length of 1·5 mm., but in adult specimens only 1 mm. is

visible. The virgella is always present and is short, straight, and robust, measuring about 1 mm. in length.

Theca 1^1 originates at a point about 1 mm. above the aperture of the sicula; it grows downward on the side of the virgella some little distance below the aperture, and then turns back, growing upward and slightly outward, so that its aperture comes to lie on a level with or slightly above its point of origin. Th. 1^2 grows obliquely across the back of the sicula, leaving it free on one side for a small fraction of its length.

FIG. 121 *a* and *b*.—*Climacograptus rectangularis* (M'Coy).

a. Proximal end in relief, reverse view. Enlargement of part of Pl. XXVI, fig. 5 *a*.
b. Young specimen probably referable to this species, obverse view showing sicula. Twymyn River, near Llanbrynmair, Dolgadfan (Birkhill Beds). Coll. Elles.

The septum originates at once between the apertures of th. 1^1 and th. 1^2, or at latest on the level of the aperture of th. 1^2. The virgula is often prolonged distally for a considerable distance.

Affinities.—There appears to have been considerable misapprehension respecting this species of M'Coy; and *Climacograptus Törnquisti*, which is in reality very different, has been commonly referred to this species. The above description has been drawn up from M'Coy's type specimens which are in the Sedgwick Museum; and his species appears therefore to have the following characteristic features:

(1) Gradual increase in breadth over first 1·5 cm. till 2·5 mm. is attained.

(2) Short conspicuous virgella proceeding from a sicula, which is free for nearly half of its length on one side.

(3) Complete septum.

It is therefore closely related to *Cl. scalaris* (with which its thecæ agree in all essentials), but differs from it in size and in the greater breadth, attained by gradual and persistent widening. From *Cl. medius* it differs in having a shorter virgella, more gradual widening, and more complete septum; from *Cl. Törnquisti*, with which it appears very frequently to have been confused, it differs entirely in the character of the proximal end.

Horizon and Localities.—Lower Birkhill Shales and equivalents.

S. Scotland: Dobb's Linn; Garple Linn; Belcraig Burn; Crosscleuch; Rittonside; Penwhapple Glen, Saugh Hill, etc. *Lake District:* Skelgill, etc. *Wales:* Pary's Mountain; Llanystwmdwy. *Ireland:* Pomeroy; Donaghadee.

Associates, etc.—*Climacog. rectangularis* is a common fossil in the Lower Birkhill Shales (particularly in the zones of *Diplog. vesiculosus* and *M. gregarius*), and their equivalents in the British Isles. Its associates are the entire Lower Birkhill fauna.

Collections.—Sedgwick Museum, British Museum (Natural History), Lapworth, Fearnsides, and the Authors.

Climacograptus medius, Törnquist. Plate XXVI, figs. 4 *a—f.*

1870. *Climacograpsus teretiusculus,* Nicholson (pars.), Ann. Mag. Nat. Hist., ser. 4, vol. vi, p. 373, figs. 1 *a, b, f.*

1872. *Climacograpsus teretiusculus,* Nicholson, Monog. Brit. Grapt., p. 33, figs. 8 *a, b, f.*

1873. *Climacograptus scalaris,* Malaise, Terr. Silur. du centre de la Belgique, p. 104, pl. vi, figs. 5, 6.

1897. *Climacograptus medius,* Törnquist, Diplog. and Heteroprionidæ of Scanian Rastrites Beds, Acta Reg. Soc. Physiogr. Lund, vol. viii, p. 7, pl. i, figs. 9—15.

Polypary 1—4 cm. in length, wide at origin, but undergoing slight increase for about the first centimetre of its length, until a maximum width of about 2·5 mm. is attained. Septum partial till the level of fourth or fifth thecal pair, thence complete. Sicula 1·5 mm. in length but partly concealed. Virgella very long, attaining a length of 10 mm. or more. Thecæ twelve to ten in 10 mm., of the same general type as those of *Cl. scalaris.*

Description.—The sicula is free for a considerable fraction of its length on one side, and in addition to the virgella there occur occasionally two basal spines, the origin of which is obscure; they seem to belong to the sicula rather than to the thecæ.

In the *obverse aspect* the septum is seen to extend down to the proximal extremity of the polypary; in the *reverse aspect,* however, there is no trace of it until the level of the fourth pair of thecæ is reached, and occasionally not until the level of the fifth; this would seem to imply that it is at first only partial, not extending completely through the polypary until the level of the fourth or fifth thecal pair.

Figs. 122 *a, b,* and *c.*—*Climacograptus medius,* Törnq.

a *b*

c

a. Proximal end, obverse view. Main Cliff, Dobb's Linn; Birkhill Shales (zone of *Diplog. vesiculosus*). Coll. Elles.
Small specimen showing two spines in addition to virgella. On same slab as Pl. XXVI, figs. 4 *a, c,* and *e.*
c. Distal thecæ showing large apertural excavations. Enlargement of part of Pl. XXVI, fig. 4 *a.*

The virgella varies in length from 5 mm. to 10 mm.; it is always therefore a more conspicuous feature than in *Cl. scalaris* or *Cl. rectangularis.* The virgula is commonly prolonged distally for a considerable extent.

Affinities.—*Cl. medius* is no doubt intimately related to *Cl. rectangularis* and *Cl. Törnquisti,* and may be regarded as an intermediate form between them. It agrees with *Cl. rectangularis* in point of size and in the characters of the thecæ; it differs, however, (1) in being wide at the proximal end and hence undergoing less increase to attain the same breadth, (2) in the possession of a much longer virgella, and (3) in the fact that the septum is not completely developed till the level of the fourth or fifth pair of thecæ. In compressed

specimens the greater length of the virgella is the most obvious point of difference.

Cl. medius agrees with *Cl. Törnquisti* in the possession of a conspicuously long virgella and in the general characters of the thecæ, but in *Cl. Törnquisti* the sicula is longer and less imbedded in the polypary, and the septum is not complete until the level of the eighth thecal pair.

Horizon and Localities.—Birkhill Shales (zones of *Diplog. vesiculosus* and *Monog. gregarius*).

S. Scotland: Dobb's Linn; Lockerbie; Duffkinnel, near Wamphray, etc. *Wales:* Llanystwmdwy; Pennant, Llanbrynmair. *Lake District:* Skelgill.

Associates, etc.—*Cl. medius* is most abundant in Britain in the zone of *Diplog. vesiculosus*; it is also fairly common in the lower part of zone of *Monog. gregarius* at the top of the Lower Birkhill Shales, and is met with occasionally at a slightly higher horizon; it is usually associated with *Diplog. vesiculosus*, *Dimorphog. Swanstoni*, *Monog. gregarius*, *M. tenuis*, *M. triangulatus*, *Cl. rectangularis*, and *Diplog. physophora*.

Collections.—Sedgwick Museum, Fearnsides, and the Authors.

Climacograptus Törnquisti, sp. nov. Plate XXVI, figs. 6 *a—f*.

1876. *Climacograptus rectangularis*, Lapworth, Cat. West Scott. Foss., pl. ii, fig. 50.

1877. *Climacograptus scalaris* var. *rectangularis*, Lapworth, Grap. Co. Down, Proc. Belfast Nat. Field Club, p. 138, pl. vi, fig. 32.

1897. *Climacograptus rectangularis*, Törnquist, Diplog. and Heteroprionidæ of Scanian Rastrites Beds, Acta Reg. Soc. Physiog. Lund, vol. viii, p. 8, pl. i, figs. 16—21.

Polypary 1—4 cm. in length, widening within 1·5 cm. to a maximum breadth of 2 mm., which is maintained to the distal extremity; sicula 2 mm. in length, only partially concealed; virgella robust and long, generally attaining a length of 10 mm. or more. Septum, partial until level of eighth thecal pair. Thecæ twelve to ten in 10 mm. of the form of those of *Cl. scalaris*.

Description.—The sicula is long, and is free for nearly the whole of its apparent length on one side, giving to the proximal end an appearance closely resembling that of a *Dimorphograptus*.

The proximal end is somewhat abnormal for a *Climacograptus*; th. 1^2 is so unusually long that its aperture is above the level of that of th. 2^1, while its direction of growth is so peculiarly upward, instead of outward and upward, that the sicula is left entirely free on one side; nevertheless the thecæ appear to develop in their usual order.

The virgula is not often preserved as a distal prolongation, but occasionally projects 10—15 mm. beyond the polypary; it is very slender as a rule, a fact which no doubt accounts for the comparative rarity of its preservation.

Figs. 123 *a* and *b*.—*Climacograptus Törnquisti*, sp. nov.

a *b*

a. Obverse view, showing sicula free on the right side. Dobb's Linn, Birkhill Shales. Coll. Elles.
b. Reverse view showing part of sicula on left side and long theca 1^2. Enlargement of part of Pl. XXVI, fig. 6 *f*.

Affinities.—Unlike the other close allies of *Climacog. scalaris*, *Cl. Törnquisti* is clearly closely related to the *Dimorphograpti*, but since th. 1^2 seems to develop as usual from th. 1^1 and the Dimorphograptid appearance is due merely to its peculiar direction of growth and unusual length, this species must be regarded as a *Climacograptus*, of which the characteristic features are the following:

(1) The long sicula, free for nearly the whole of its apparent length on one side.

(2) The long virgella.

(3) The incomplete septum until the level of the eighth thecal pair is reached.

Cl. Törnquisti is undoubtedly closely related to *Cl. rectangularis* and *Cl. medius*; distal fragments of *Cl. Törnquisti* and *Cl. rectangularis* are almost indistinguishable, but when the proximal end is preserved the longer sicula, long virgella, and less complete septum in *Cl. Törnquisti* serve to distinguish it. It is often very difficult to separate it from *Cl. medius*, especially in compressed specimens when the details of the proximal end are obscure and the septal groove invisible; but in well-preserved specimens the sicula of *Cl. Törnquisti* is seen to be longer and less imbedded in the polypary than is the case in *Cl. medius*, and while the septum is not complete until the level of the eighth thecal pair, it is always complete in *Cl. medius* after the fifth.

Horizon and Localities.—Lower Birkhill Shales (rare in Upper Birkhill Shales).

S. Scotland: Dobb's Linn; Belcraig; Garple Linn. *Wales:* Big Pit, east side of Pary's Mount; Mona Mine, Pary's Mount; Llanystwmdwy. *Lake District:* Skelgill. *Ireland:* Donaghadee, Little River, Pomeroy.

Associates, etc.—*Cl. Törnquisti* is a common fossil in the Lower Birkhill Shales, and is especially abundant in the zone of *Monog. gregarius*. It occurs most frequently associated with *Monog. gregarius*, *Monog. cyphus*, *Monog. fimbriatus*, *Monog. triangulatus*, *Cl. rectangularis*, *Cl. innotatus*. It is only rarely met with in the higher beds of the Birkhill Shales.

Collections.—British Museum (Natural History), Sedgwick Museum, Lapworth, Fearnsides, and the Authors.

Climacograptus minimus (Carruthers). Plate XXVII, figs. 1 *a*—*g*.

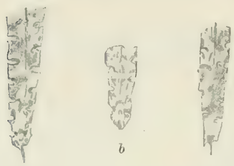
1868. *Diplograpsus minimus*, Carruthers, Geol. Mag., vol. v, p. 125, pl. v, figs. 12 *a*, 12 *b*.

Polypary 1—3 cm. in length, increasing gradually in breadth till a maximum of nearly 2 mm. is attained. Sicula visible for 1 mm. of length; virgella fairly short; virgula distally prolonged. Thecæ fourteen to eleven in

10 mm., having an average length of 1·5 mm., overlapping about one-half their extent; apertural margin horizontal, situated in deep excavation occupying fully one-third of the width of the polypary and one-fourth of its ventral margin.

Description.—The polypary measures 0·8 mm. in width at the proximal end, but widens within 4 mm. to its maximum breadth, so that the margins are parallel to each other for the greater part of their extent.

FIGS. 124 *a—c.*—*Climacograptus minimus* (Carr).

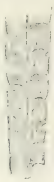


b

a c

a. Proximal end, obverse view. On same slab as Pl. XXVII, fig. 1 *g*.
b. Obverse view, showing sicula. Dobb's Linn, Hartfell Shales (zone of *Pleurog. linearis*). Coll. Elles.
c. Reverse view. On same slab as Pl. XXVII, figs. 1 *a—c*.

FIG. 124 *d.* — *Climacograptus minimus* (Carr).



d

d. Distal thecæ. Enlargement of part of Pl. XXVII, fig. 1 *f*.

In the reverse aspect of the polypary the proximal end has a very compact and rounded off appearance, and the only part of the sicula visible is its virgella. In the obverse aspect the sicula is seen for 1 mm. of its extent; th. 1^1 originates 1·3 mm. above the aperture, and the polypary develops in the usual manner. In one specimen the virgula is seen to be expanded into a small vesicle.

The septum originates at once between th. 2^1 and th. 2^2.

Affinities.—*Cl. minimus* is a form originally described by Carruthers as a *Diplograpsus*, but the characters of the thecæ proclaim its connection with the *Climacograpti*. It is characterised by its relatively great width in proportion to its length, a feature which serves to distinguish it from allied forms, such as *Cl. brevis*.

Horizon and Localities. — Hartfell Shales (*Dicranog. Clingani* and *Pleurog. linearis* zones).

S. Scotland: Dobb's Linn; Hartfell; Mount Benger Burn. *Wales:* Railway Pendwr, south of Bletherston ?

Collections.—British Museum (Natural History), Lapworth, and the Authors.

Climacograptus brevis, sp. nov. Plate XXVII, figs. 2 *a—f*.

1885. *Cl.* cfr. *minutus*, Marr and Roberts, Quart. Journ. Geol. Soc., vol. xli, p. 476.

Polypary small, about 1·5 cm. in length and having an average uniform width of about 1 mm. Sicula 1 mm. in length; virgella conspicuous; virgula distally prolonged. Thecæ fourteen to ten in 10 mm., nearly opposite, short tubes having an average length of about 1 mm., overlapping about one-

third; apertures situated in semicircular excavations, which occupy one third to one quarter the width of the stipe, and one third of the ventral margin.

Description.—Cl. brevis is a small species; it may attain a length of 1·5 cm. as a maximum, but specimens having a length of 1 cm. are of commoner occurrence, and the breadth is as a rule rather less than 1 mm. The thecal apertures are nearly opposite to each other, and the outer walls are straight or slightly widened with a tendency to rounding off at the base.

FIGS. 125 *a* and *b*.—*Climacograptus brevis*, sp. nov.

a *b*

a. Proximal end, obverse view, showing apex of sicula. Enlargement of part of Pl. XXVII, fig. 2 *a*.
b. Small but complete specimen, reverse view, showing basal part of sicula free for short distance on left side. Gwern-y-fed-fach, Builth; Llandeilo Beds. Coll. Elles.

Affinities.—This species is obviously very closely allied to *Cl. minimus* in point of size and in the general characters of the thecæ; its chief distinction lies in the lesser breadth and smaller degree of overlap of the thecæ and larger apertural excavations. From all other forms it may be distinguished by its small size and the characters of its thecæ.

Horizon and Localities.—Llandeilo Flags; Glenkiln and Lower Hartfell Shales; Dicranograptus Shales.

S. Scotland: Dobb's Linn; Hartfell; Mount Benger Burn. *Wales:* Gwern-y-fed-fach, Builth; S. of Wolfsdale; Parsonage Llandewy Velfry; Clarbeston Road Railway Station; Spittal Road Cutting.

Associates, etc.—Cl. brevis is a common fossil in the Llandeilo Flags of Gwern-y-fed-fach, near Builth, where it is found on the same slabs as *Nemag. pertenuis* and *Dicellog. sextans*. It is also found in the Glenkiln Shales of S. Scotland, and in the *Dicranograptus* Shales of S. Wales. It appears to belong characteristically to this horizon, but some individuals survive into the Lower Hartfell Shales.

Climacograptus bicornis (Hall). Plate XXVI, figs. 8 *a—f*.

1847. *Graptolithus bicornis*, Hall, Pal. New York, vol. i, p. 268, pl. lxxiii, fig. 2.

1870. *Climacograpsus bicornis*, Nicholson, Ann. Mag. Nat. Hist., ser. 4, vol. vi, p. 380, figs. 5 *a, b, c, d*.

1874. *Climacograptus bicornis*, Dairon, Trans. Geol. Soc. Glasgow, vol. v, p. 183, pl. i, fig. 25.

1876. *Climacograptus bicornis*, Lapworth, Cat. West Scot. Foss., pl. ii, fig. 51.

1877. *Climacograptus bicornis*, Lapworth, Grap. Co. Down, Proc. Belfast Nat. Field Club, p. 139, pl. vi, fig. 38 *a*.

1902. *Climacograptus bicornis* var. *longispina*, T. S. Hall, Records Geol. Survey N.S. Wales, vol. vii, pt. 2, p. 5, pl. xii, figs. 8, 9.

Polypary 2—6 cm. in length, widening gradually from origin until a

Figs. 126 *a*, *b*, *c*, and *d*.—*Climacograptus bicornis* (Hall).

a *b* *c* *d*

a. Proximal end showing part of sicula, and apertural edges of proximal thecæ prolonged into spines. Dobb's Linn, Lower Hartfell Shales (zone of *Climacog. Wilsoni*). Coll. Elles.
b. Proximal end showing aperture of th. 1[1]. Ibid.
c. Distal thecæ, half profile view. Dobb's Linn, Lower Hartfell Shales. Coll. Wood.
d. Distal thecæ, sub-scalariform view. Ibid. Coll. Lapworth.

maximum width of 2·5 mm. is attained, then continuing with parallel margins up to the distal end; proximal end provided with two conspicuous spines. Sicula small. Thecæ twelve to ten in 10 mm., having an average length of 1·5 mm. and overlapping about one-third of their extent; apertural margins horizontal, situated in elliptical excavations occupying one-third of the ventral margin and one-quarter the width of the polypary.

Description.—The polypary varies very much in size and may attain a length of 6 cm. or more, but specimens having a length of 3—4 cm. are of commoner occurrence; when compressed the polypary measures ·8 mm.—1 mm. in breadth at its origin, but specimens preserved in relief generally only measure ·6 mm. The increase is gradual in a distal direction, but the maximum breadth is usually attained within the first four centimetres of length. At 1 cm. the polypary is 1·5 mm. wide, at 2 cm. 2 mm., at 3 cm. about 2·2 mm., and at 4 cm. 2·5 mm.

The sicula is small; when complete it measures approximately 1 mm. in length, but since the whole of the apical region is imbedded in the fully developed polypary the visible length as a rule is only ·5 mm. In the case of very young specimens the sicula is completely visible. The virgella can often be seen as a small stout projection from the sicular aperture, and the virgula is occasionally prolonged beyond the distal extremity of the polypary.

Th. 1[1] originates about ·5 mm. above the aperture of the sicula (*i.e.* at the top of the visible portion in a mature specimen) and grows downward until it reaches the level of the aperture. It then bends round and grows outward and slightly upward, so that its own aperture is slightly below the level of its point of origin. A spine is always present on each side of the base of the polypary; in some cases these spines are merely outgrowths from the outer walls of the earliest thecæ just below their apertures, but often a complete modification of th. 1[1] and th. 1[2] to spines appears to have taken place and no aperture can be discerned. There appears to be every stage between these two extremes. The spines vary very much in size, and, as Nicholson long ago observed, they may be anything from 1 mm. to 1 cm. in length, and may be curved and long, or straight and short; the angle

included between them appears to vary from 60° to 140°. They are frequently enclosed partially or entirely within a membrane, which gives a false impression of their actual width.

The appearance of the thecæ varies very much with preservation. They are comparatively rarely presented in true profile view; when so presented, however, while a marked sigmoid curve is characteristic of the line of the ventral wall, the free edge is practically straight. Each theca starts from the inner part of the theca lying next below, and almost at once grows outward and upward, so that the greater part of its ventral wall is free; the amount of overlap is approximately one-third, or rather less. The thecæ are, however, often preserved in sub-scalariform view, when the aperture is seen to be elliptical in outline. In profile view the thecal apertures are markedly alternate in their arrangement, particularly so at the proximal end. The septum is complete on the obverse side, but possibly incomplete at the extreme proximal end on the reverse side.

Affinities.—The presence of the basal spines, the characters of the thecæ, and the tapering of the polypary in a proximal direction are characteristics which serve to separate *Cl. bicornis* from other *Climacograpti.*

Horizon and Localities.—Upper Glenkiln and Hartfell Shales.

S. Scotland: Dobb's Linn; Hartfell; Kirkhill, Wanlock Head; Berrybush Burn; Black Linn; Glenkiln Burn; Craighead; Laggan Gill; S. of Ardwell; Penwhapple Glen, etc. *Wales:* Tiddyndicwm; Derwendeg; Ty Fry; Prendergast Farm, Haverfordwest; Railway Pendwr, S. Bletherston; near Builth, etc. *Ireland:* Tinnaclough, Co. Wexford.

Associates, etc.—*Cl. bicornis* is an exceedingly abundant fossil in the Glenkiln and Lower Hartfell Shales. In the Glenkiln Shales it occurs in the *Nemag. gracilis* zone associated with *N. gracilis*, *Dicellog. sextans*, and *Climacog. Scharenbergi*; in the immediately overlying zone of *Dicellog. patulosus* it occurs with *Cl. peltifer* and the zone fossil; while in the Lower Hartfell Shales it abounds in the *Cl. Wilsoni* zone, associated with *Cl. Wilsoni*, *Cl. Scharenbergi*, and *Dicranog. Nicholsoni.* Some individuals are met with in the higher zone of *Dicranog. Clingani*, associated with *D. Clingani*, *Dicellog. Morrisi*, *Dicranog. ramosus*, and *Leptog. flaccidus.*

Collections.—Geological Survey of Scotland, Sedgwick Museum, Lapworth, and Authors.

Var. **tridentatus,** Lapworth. Plate XXVI, figs. 9 *a*—*c*.

1876. *Climacograptus bicornis*, var. *tridentatus*, Lapworth, Cat. West Scot. Foss., pl. ii, fig. 52.
1877. *Climacograptus bicornis*, var. *tridentatus*, Lapworth, Grap. Co. Down, p. 139, pl. vi, fig. 38 *c*.

There is a well-marked variety of *Cl. bicornis* in which the virgella is so developed that it constitutes a third long basal spine; it is often fully 2 mm. in

length. In other respects this form agrees with the typical species. A membrane frequently surrounds each spine, giving to all an appearance of greater width than they naturally possess.

Horizon and Localities. — Upper Glenkiln and Lower Hartfell Shales.

S. Scotland: Hartfell; Dobb's Linn; Wanlock Water, etc. *Wales:* Ty Fry, near Portmadoc. *Ireland:* Ballygrot.

Associates, etc.—Var. *tridentatus* is a somewhat rare fossil in the Glenkiln Shales (zone of *Dicellog. patulosus*), where it occurs associated with *Cl. bicornis*, *Cl. peltifer*, *Cl. Scharenbergi*. It also occurs in the succeeding Lower Hartfell Shales (zone of *Cl. Wilsoni*), associated with *Cl. Wilsoni* and *Dicranog. Nicholsoni*.

Collections.—Lapworth and the Authors.

Var. **peltifer,** Lapworth. Plate XXVI, figs. 10 *a—c*.

1876. *Climacograptus bicornis*, var. *peltifer*, Lapworth, Cat. West Scot. Foss., pl. ii, fig. 53.
1877. *Climacograptus bicornis*, var. *peltifer*, Lapworth, Grap. Co. Down, Proc. Belfast Nat. Field Club, p. 139, pl. vi, fig. 38 *b*.

A common variety of *Cl. bicornis* is one in which the membrane surrounding the basal spines has developed to such an extent as to envelop the entire proximal end of the polypary in a triangular disc. The spines form the proximal termination of the disc, which thence extends upward for a distance of 4—5 mm. The thecæ agree in most particulars with those of *Cl. bicornis* (though the apertural excavations are somewhat smaller, occupying one-fifth of the breadth of polypary as compared with one-fourth in the typical form); the form of the polypary is also similar.

Horizon and Localities.—Upper Glenkiln Shales (zone of *Dicellog. patulosus*).

S. Scotland: Dobb's Linn; Hartfell, etc. *Wales:* Tiddyndicwm. *Ireland:* Ballygrot; Coalpit Bay.

Associates, etc.—Var. *peltifer* is a fairly abundant fossil in the Moffat country in the highest beds of the Glenkiln Shales immediately below the zone of *Cl. Wilsoni*; with *Dicellog. patulosus* in most places marking a clearly recognisable zone. It is commonly associated with *Cl. bicornis*, *Cl. Scharenbergi*, and *Cl.* (?) *perexcavatus*.

Collections.—Lapworth and the Authors; Fearnsides.

Climacograptus supernus, sp. nov. Plate XXVI, figs. 11 *a—d*.

Polypary small, 1—2 cm. in length, widening somewhat rapidly from about 0·5 mm. to a maximum breadth of 1·2 mm., which is thereafter maintained. Sicula about 1 mm. in length; virgella short and robust. Thecæ of the general *bicornis* type, fourteen to twelve in 10 mm.

Description.—The polypary is generally small, the increase in breadth takes place within 5 mm. of the proximal end, but it is noticeable that the polypary is often slightly wider at its extreme proximal end than it is opposite the apertures of th. 2^1 and th. 2^2, a fact which seems to be accounted for by the presence of the sicula, which is broad at its aperture, but tapers quickly in its apical region.

FIGS. 127 *a—d.*—*Climacograptus supernus*, sp. nov.

a. Proximal end, obverse view, showing small virgella. Enlargement of part of Pl. XXVI, fig. 11 *b*.
b. Reverse view, showing long spines. Dobb's Linn, Upper Hartfell Shales (zone of *Dicellog. anceps*). Coll. Wood.
c. Obverse view, showing sicula. Ibid. Coll. Elles.
d. Small specimen, with proximal end enclosed in a small disc. On same slab as fig. 129 *c*.

The sicula is commonly situated somewhat obliquely, and is often visible for only 0·5 mm. of its extent; th. 1^1 originates at the top of the visible portion, grows downward and then upward, giving off a slender spine about 1 mm. in length from the base of the upward growing portion; th. 1^2 grows somewhat obliquely upward and outward from th. 1^1, originating a similar spine from the base of its upward growing portion. The virgella usually appears as a medial excrescence between them. Occasionally the whole proximal end appears to be enveloped in a disc.

Affinities.—In its general form and the characters of the thecæ, and above all in the presence of the basal spines, *Cl. supernus* bears obvious resemblance to *Cl. bicornis;* it is, however, a much smaller form, is narrower, and has the thecæ more closely set, its spines are also more slender than those of *Cl. bicornis*; it is, however, not impossible that it is the dwarfed survival of that species.

Horizon and Locality.—Upper Hartfell Shales (confined to zone of *Dicellog. anceps*).

S. Scotland.—Dobb's Linn; Hartfell, etc.

Associates, etc.—*Cl. supernus* is a fairly common fossil in the *Dicellog. anceps* zone, especially at Dobb's Linn, where it occurs on the same slabs as *D. anceps*.

Collection.—The Authors.

Climacograptus Wilsoni, Lapworth. Plate XXVI, figs. 12 *a—d*.

1876. *Climacograptus Wilsoni*, Lapworth, Cat. West Scot. Foss., pl. ii, fig. 46.

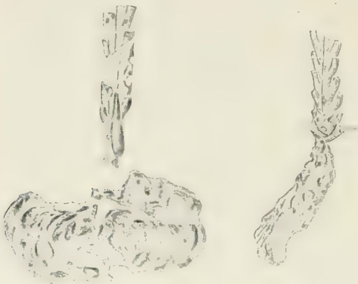
1877. *Climacograptus Wilsoni*, Lapworth, Grap. Co. Down, Proc. Belfast Nat. Field Club, p. 140, pl. vi, fig. 40.

Polypary 2—6 cm. or more in length, increasing gradually in breadth up to a maximum of 2·5 mm., which is then maintained up to the distal extremity. Sicula 2·5 mm. in length, proximal end commonly furnished with a conspicuous vesicle of elliptical form. Thecæ twelve to eight in 10 mm., overlapping one-third to one-half their length, with slightly curved sub-

perpendicular free wall; apertural margin horizontal, situated in semicircular excavations occupying one-fourth the width of the polypary and one-fourth of the ventral margin.

Description.—The polypary often attains the considerable length of 5 or 6 cm. or more; it is usually 1 mm. wide at its origin, but may increase gradually up to a maximum breadth of 2·5 mm.; this is only rarely attained in the largest specimens, an average breadth of 2 mm. being of commoner occurrence. The sides of the polypary are subparallel, except at the proximal end. In the *obverse aspect* of the adult the sicula is visible for 2·5 of its length, and is entirely free in its apertural region for fully 1 mm; the apical region tends to be more or less completely concealed by the growth of th. 3^1 and th. 3^2. Th. 1^1 originates from the sicula fully 2 mm. above its aperture, and grows at first downward, partly embracing the left side of the sicula; it then bends abruptly round and grows outward and upward for a distance of about 0·5 mm. A spinous outgrowth from the thecal wall of th. 1^1 below its aperture may also occasionally be seen. Th. 1^2 shows a similar outgrowth. The apertural part of th. 1^2 is all that is visible in this aspect, since its initial portion (crossing canal) is concealed by the sicula. Th. 2^1 seems to develop from the back of th. 1^2 and grow behind the sicula; th. 2^3 grows similarly from the back of th. 2^1; and th. 3^1 appears to grow from the front of th. 2^2, thereby concealing part of the apex of the sicula. At this stage the septum appears; thus it happens that in the fully developed polypary the apex of the sicula is concealed, although in younger stages of growth it is as a rule completely visible.

Figs. 128 *a* and *b*.—*Climacograptus Wilsoni*, Lapw.



a *b*

a. Specimen showing proximal end in relief, obverse view. Note large sicula and origin of sac. Dobb's Linn, Lower Hartfell Shales. Coll. Wood.
b. Reverse view, showing spines on basal thecæ; sac distorted. Ibid. Coll. Elles.

Fig. 128 *c*. — *Climacograptus Wilsoni*, Lapw.

c

c. Distal thecæ. Dobb's Linn, Lower Hartfell Shales. Coll. Wood.

In the *reverse aspect* the alternate development of the earliest thecæ can be clearly made out. The early growth of th. 1^2 is approximately horizontal in direction; but ultimately it grows outward and upward. Th. 2^1 is also horizontal at first, but th. 2^2 grows at once outward and upward. The septum now appears, and in subsequently developed thecæ the growth is first upward, then slightly outward, and finally again upward.

In *Cl. Wilsoni* the thecæ number twelve to eight in 10 mm., they have an average length of 2 mm., and overlap one-third to one-half their extent; the free part of the outer wall tends to curve slightly inward; the apertural margins are approximately horizontal and are situated in semicircular excavations occupying about one-fourth of the entire width of the polypary, though they frequently appear somewhat wider when the polypary is compressed from the side. The characteristic feature of *Cl. Wilsoni* is certainly the presence of the sac or vesicle at the proximal end; this appears to originate as an expansion of a membrane surrounding the sicula, which in this species projects from the main body of the polypary to an extraordinary degree. This sac is commonly elliptical in form, and may measure 10 by 5 mm. (smaller ones are of frequent occurrence), it varies greatly in shape under compression, and is often merely a flattened irregular-shaped body.

Affinities.—The only other known *Climacograptus* furnished with a sac at the proximal end is *Cl. antiquus* var. *bursifer*, but the sac is much closer to the polypary in *Cl. Wilsoni* and the characters of the thecæ are different.

Horizon and Localities.—Lower Hartfell Shales (zone of *Cl. Wilsoni*).

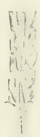
S. Scotland: Dobb's Linn; Hartfell; Glenkiln Burn; Black Linn; Moory Syke, etc., etc.

Associates, etc.—*Cl. Wilsoni* occurs in great numbers in S. Scotland at the base of the Hartfell Shales, where it marks a well-defined zone. It is commonly associated with *Cl. bicornis*, *Cl. Scharenbergi*, *Dicranog. Nicholsoni*.

Collections.—Geological Survey of Scotland, Lapworth, and the Authors.

Var. **tubularis**, var. nov. Plate XXVI, fig. 13.

FIG. 129.—*Climacograptus Wilsoni*, var. *tubularis*, nov.



Proximal end, showing sicula and commencement of the tube. On same slab as Pl. XXVI, fig. 13.

There are some forms of *Cl. Wilsoni* in which no sac is developed but in which there occurs a proximal elongated tube similar to that seen in *Cl. caudatus*. These seem to constitute a distinct variety. The characters of the thecæ are similar to those of *Cl. Wilsoni* itself.

Horizon, Localities, etc.—Those of the typical form.

Collection.—Lapworth.

GROUP II.

Climacograpti in which the free edge of the theca is slightly inclined, and the apertural margin somewhat introverted.

Climacograptus antiquus, Lapworth. Plate XXVII, figs. 4 *a*—*e*.

1873. *Climacograptus antiquus*, Lapworth, Geol. Mag., vol. x, p. 134.

1876. *Climacograptus cœlatus*, Lapworth, Cat. West Scott. Foss., pl. ii, fig. 56.

1877. *Climacograptus cœlatus*, Lapworth, Grap. Co. Down, pl. vi, fig. 39.
1886. *Climacograptus cœlatus*, Lapworth, Trans. Roy. Soc. Canada, sect. iv, p. 167.

FIGS. 130 *a* and *b*.—*Climacograptus antiquus*, Lapw.

a *b*

a. Typical specimen showing basal spines and long virgella, surrounded partially by a membrane. On same slab as Pl. XXVII, fig 4 *a*.
b. Proximal end showing stout tubular spines. Enlargement of part of Pl. XXVII, fig. 4 *d*.

FIGS. 130 *c* and *d*.—*Climacograptus antiquus*, Lapw.

d

c. Distal thecæ showing their typical form. Enlargement of part of Pl. XXVII, fig. 4 *d*.
d. Distal part of polypary showing growths on the distal prolongation of the virgula. Oak Wood, Pontesford. Coll. Lapworth.

Polypary 3—5 cm. long, with an approximately uniform width of 2·5 mm. for the greater part of its length. Sicula imbedded, virgella long; virgula conspicuous and of considerable length. Thecæ eleven to nine in 10 mm., basal ones with spines, length 1·5 mm., overlap one-third, apertural margins slightly introverted, situated in conspicuous elliptical excavations occupying one-fourth to one-fifth of the breadth of polypary and one-third of its ventral margin.

Description.—The proximal end is rounded, and the polypary measures 1 mm. in breadth, widening, however, to 2·5 mm. within the first cm. of its extent. The virgella is occasionally partly enclosed within a membranous tube similar to that found in *Cl. caudatus*, but the proximal tapering of the polypary so noticeable in that species is here absent. The two proximal thecæ occasionally bear a stout spine in the middle of the free straight part of the outer wall.

Affinities.—*Cl. antiquus* recalls *Cl.* (*?*) *cœlatus* in many respects, especially as regards its general form, but it differs in the characters of its thecæ.

Horizon and Localities.—Glenkiln Shales. Llandeilo.

N. Wales: Ty-Obry; Tiddyndicwm. *S. Scotland:* Dobb's Linn; Glenkiln Burn; Craigmichan Scaurs; Berrybush Burn; Kirkmichael Burn; Black Linn; Penwhapple Glen. *N. Ireland:* Ballygrot; Coalpit Bay. *S. Shropshire:* Oakwood, Pontesford.

Associates, etc.—*Cl. antiquus* occurs in the Glenkiln Shales associated with *Didymog. superstes* and *Cl.* (*?*) *perexcavatus*.

The best specimens (including the type) are in Lapworth's Collection.

Var. **bursifer**, var. nov. Plate XXVII, figs. 6 *a—d*.

FIGS. 131 *a* and *b*.—*Climacograptus antiquus*, var. *bursifer*, nov.

a. Proximal end showing disc. Enlargement of part of Pl. XXVII, fig. 6 *c*.
b. Distal thecæ. Enlargement of part of specimen on same slab as fig. 134 *a*.

A variety of *Cl. antiquus* which is occasionally met with in the Glenkiln Shales differs from the typical form in possessing more closely-set thecæ, and in having the membrane connected with the proximal tube swollen out into a sac at some distance from the polypary.

The thecæ number fourteen to twelve in 10 mm. and have their ventral walls distinctly inclined; the sac is fully 6 mm. below the sicula.

Affinities.—Var. *bursifer* presents obvious resemblances to *Cl. Wilsoni*, but differs (1) in having the sac at a greater distance from the polypary and (2) in the characters of the thecæ, whose ventral walls are more inclined and the apertures more introverted.

Horizon and Localities.—Glenkiln Shales and their equivalents.

S. Scotland: Kirkmichael Burn. *Wales:* Tid-dyndicwm.

Associates, etc.—Those of the typical form.

Collections.—Lapworth and Fearnsides.

Var. **lineatus**, var. nov. Plate XXVII, figs. 5 *a—f*.

FIGS. 132 *a*, *b*, and *c*.—*Climacograptus antiquus*, var. *lineatus*, nov.

a. Proximal end showing basal spines. Enlargement of part of Pl. XXVII, fig. 5 *a*.
b. Distal thecæ, showing profile of excavations. Enlargement of part of Pl. XXVII, fig. 5 *b*.
c. Distal thecæ. Enlargement of part of specimen on same slab as Pl. XXVII, fig. 5 *e*.

Another variety of *Cl. antiquus*, which occurs at a slightly higher horizon than the typical form and is characterised by its extreme length, may be appropriately distinguished as var. *lineatus*. In this variety the polypary may have a length of 8 cm. but never exceeds 2 mm. in breadth; the thecæ are rather more distant than in the typical form, numbering only eight to nine in 10 mm.; in other particulars they agree with those of *Cl. antiquus* itself.

Horizon and Localities.—Upper Glenkiln Shales and Lower Hartfell Shales.

S. Scotland: Craigmichan Scaurs. *Wales:* Llanystwmdwy; Conway; Spittal Road Cutting.

Collections.—Fearnsides; Sedgwick Museum.

Climacograptus caudatus, Lapworth. Plate XXVII, figs. 7 *a—e*.

1876. *Climacograptus caudatus*, Lapworth, Cat. West Scott. Foss., pl. ii, fig. 48.
1877. *Climacograptus scalaris* var. *caudatus*, Lapworth, Grapt. Co. Down, p. 138, pl. vi, fig. 34.

Polypary 2—6 cm. or more in length exclusive of the virgellar prolongation, widening gradually from its proximal end to a maximum breadth of about 2—2·5 mm., which is then maintained to the distal extremity. Sicula obscure, virgella 1—3 cm. or more in length; virgula considerably prolonged. Thecæ twelve to nine in 10 mm., free outer edge curved, slightly inclined. Apertural margin horizontal or introverted; situated in excavations occupying one-fourth the width of the stipe and one-third of its ventral margin.

Figs. 133 *a* and *b*. — *Climacograptus caudatus*, Lapw.

a. Proximal end, showing long tube-like virgella surrounded partially by a membrane. Enlargement of part of specimen on same slab as Pl. XXVII, fig. 7 *e*.
b. Ditto. Enlargement of part of specimen on same slab as Pl. XXVII, fig. 7 *b*.

Figs. 133 *c* and *d*. — *Climacograptus caudatus*, Lapw.

c. Distal thecæ seen in profile view. Enlargement of part of specimen in same slab as Pl. XXVII, fig. 7 *b*.
d. Distal thecæ in sub-scalariform view. Enlargement of another specimen on same slab.

Description.—In the distal region of the polypary the margins are parallel, but proximally they very markedly approximate, the maximum width being attained at a distance of about 2·5 cm. from the proximal end. The proximal prolongation of the virgella is very striking and characteristic, being 1—3 cm. or more in length; close to the polypary it is frequently surrounded by a membranous body with a length of 3 mm. to 1·3 cm.; this is clearly not a part of the true polypary, though it sometimes appears like a prolongation of it; probably the whole sicula was once surrounded by a membrane as in *Cl. Wilsoni*. The sicula does not appear to be free on either side for any part of its length.

The septum seems to be complete throughout the entire extent of the polypary. The free outer edges of the distal thecæ in this species are distinctly inclined, and point in the direction of those of *Diplograptus*.

Affinities. — *Cl. caudatus* bears a superficial resemblance to the Birkhill forms *Cl. Törnquisti* and *Cl. medius* in the long extension of the virgella; from these it may, however, be distinguished by

the character of the thecæ and its complete septum. There is also a great difference in size, *Cl. caudatus* being a much larger form than either of these species.

Horizon and Localities.—Hartfell Shales (zone of *D. Clingani*).

S. Scotland: Dobb's Linn; Hartfell Spa; Glenkiln Burn; Black Linn; Piedmont Glen; Ardwell Farm; Penwhapple Glen; Tralodden. *Ireland:* Ballygrot.

Associates, etc.—*Cl. caudatus* is a fairly abundant fossil in the zone of *Dicranog. Clingani* in S. Scotland; it occurs in association with the zone fossil and *Dicellog. Morrisi*.

Collections.—Sedgwick Museum, Lapworth, and the Authors.

Climacograptus tubuliferus, Lapworth. Plate XXVII, figs. 8 *a*—*d*.

1876. *Climacograptus tubuliferus*, Lapworth, Cat. West Scot. Foss., pl. ii, fig. 49.
1877. *Climacograptus scalaris* var. *tubuliferus*, Lapworth, Grap. Co. Down, p. 138, pl. vi, fig. 33.

Polypary 3—6 cm. or more in length, increasing in width very gradually from 0·7 mm. at the proximal end to a maximum of 2·5 mm., which is thereafter maintained. Sicula visible for about 1 mm. of length, virgella very robust, often 4 mm. long. Thecæ twelve to eight in 10 mm., free edge straight or slightly curved in profile view, apertural margins slightly introverted, lying within semicircular excavations which occupy about one-fourth to one-sixth the width of the polypary. Virgula conspicuous, flattened, distally prolonged for 3 cm. or more, often enclosed within a membranous tube or vesicle.

Figs. 134 *a* and *b*. — *Climacograptus tubuliferus*, Lapw.

a. Typical form of proximal end, showing rod-like virgella. Enlargement of part of specimen on same slab as Pl. XXVII, figs. 8 *a*, *b*, *d*.
b. Reverse view. Belcraig Burn, Hartfell Shales. Coll. Wood.

Description.—The polypary is often of considerable extent; the increase in width from 0·7 mm. to 2·5 mm. extends over a length of 3 cm., so that smaller specimens naturally appear to widen throughout their length. Lapworth states that the polypary has parallel margins, but this is only true of the distal parts of long specimens. The virgula is prolonged for 3 cm. or more beyond the distal extremity of the polypary, and is commonly enclosed within a long narrow flattened or tubular vesicle; this is frequently only visible when it leaves the polypary, but in other cases the presence of this flattened plate can be made out within the polypary itself.

The sicula is visible for about 1 mm. of its length. Th. 1^1 originates at a point about 0·5 mm. above its aperture, and grows down to the level of the aperture, and then upward and outward, so that the aperture is on a level with the point of origin; th. 1^2 grows horizontally across the back of the sicula, which is thus scarcely visible in the reverse aspect of the polypary. Short spines arising from the outer walls of th. 1^1 and th. 1^2 just below their apertures are occasionally visible.

FIG. 134 *c.*—*Climacograptus tubuliferus*, Lapw.

c

c. Distal thecæ. Enlargement of part of specimen on same slab as Fig. 136 *a*.

The thecæ have an average length of 2 mm. in the distal portions of the polypary, but in the proximal region they do not exceed 1 mm. in extent; the overlap is approximately one-third. The apertural margins, when seen in true profile, occupy one-fourth of the breadth of the polypary at the proximal end, but distally only about one-sixth.

Affinities.—The very gradual increase in width and the broad flattened virgular tube constitute the characteristic features whereby *Cl. tubuliferus* may be separated from any other known form of *Climacograptus*.

Horizon and Localities.—Lower Hartfell Shales (zones of *Dicranog. Clingani* and *Pleurog. linearis*).

S. Scotland: Dobb's Linn; Hartfell Spa; Belcraig Burn; Mount Benger Burn; Whitehouse, Ardmillan Shore; Myoch Bay. *Ireland:* Carnalea.

Associates, etc.—*Cl. tubuliferus* is a fairly common fossil in the zone of *Pleurog. linearis* of S. Scotland, but it is rare in the zone of *Dicranog. Clingani.* It is generally found in association with *Pleurog. linearis* and *Cl. styloideus.*

Collections.—Sedgwick Museum, Lapworth, and the Authors.

Climacograptus latus, sp. nov. Plate XXVII, fig. 3 *a—h*.

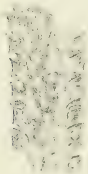
Polypary from 2 to 3 cm. or more in length, widening quickly from 1 mm. at its origin to 2 mm., and then more gradually till the maximum of 2·5 mm. is attained. Sicula visible for 0·5 mm. of length. Virgella 1 mm. in extent. Thecæ thirteen to ten in 10 mm., basal ones adorned with spines, markedly alternate at proximal end, free edge slightly inclined, average length 1·5 mm., overlapping half of it; apertural margin slightly introverted, lying within deep and approximately semicircular excavations which occupy one-fourth to one-fifth of the breadth of the polypary.

FIG. 135 *a—c.—Climacograptus latus*, sp. nov.

a *b* *c*

a. Proximal end, obverse view. Dobb's Linn, Upper Hartfell Shales (zone of *Dicellog. anceps*). Coll. Elles.
b. Reverse view showing basal spines well. Ibid. Coll. Wood.
c. Reverse view showing a somewhat different appearance of the proximal end. Enlargement of part of Pl. XXVII, fig. 3 *g*.

FIG. 135 *d.—Climacograptus latus*, sp. nov.



d.

d. Distal thecæ, showing great width of distal part of polypary. Enlargement of part of Pl. XXVII, fig. 3 *d*.

Description.—The rapid increase in width in the earlier and the more gradual increase in the later stages of growth are extremely characteristic of this species. The average length of the distal thecæ is 2 mm., but the proximal thecæ are much shorter and grow more horizontally than is commonly the case in the *Climacograpti*, and the lateral excavations are deeper.

Affinities.—*Cl. latus* may be distinguished from all other *Climacograpti* by (1) the relatively great width of the polypary compared with the relative shortness of the thecæ at the proximal end, (2) the rapid increase in width for the first few millimetres of growth, and (3) the more gradual increase at a later stage.

Horizon and Locality.—Upper Hartfell Shales (zone of *Dicellog. anceps*).

S. Scotland.—Dobb's Linn.

Associates, etc.—*Cl. latus* occurs with *D. anceps* at the top of the Hartfell Shales; it is not a common fossil.

Collection.—The Authors.

Climacograptus styloideus, Lapworth MS. Plate XXVII, figs. 9 *a—e*.

1878. *Climacograptus styloideus*, Lapworth, Quart. Journ. Geol. Soc., vol. xxxiv, p. 330.

Polypary long and narrow, from 4 to 7 cm. in length, and with a breadth of 2—2·5 mm., which is attained early, so that the margins are subparallel for the greater part of their length. Sicula 3 mm. in length, virgella short, virgula long. Thecæ, overlapping for very small fraction of their extent, twelve to eight in 10 mm., 1·5 mm. in length. Apertural margin oblique, situated in narrow elliptical excavations occupying one-fourth to one-third of the width of the polypary.

Description.—The polypary varies much in length (but the longer specimens are the more characteristic); it has the appearance of being bluntly pointed at the proximal end. The virgella is but rarely preserved, and although the two

Figs. 138 *a* and *b*.—*Climacograptus styloideus*, Lapw. MS.

a *b*

a. Proximal end, showing virgella. Enlargement of part of specimen on same slab as Pl. XXVII, fig. 9 *c*.
b. Proximal end, showing various aspects of the thecæ. Enlargement of part of specimen on same slab as Pl. XXVII, fig. 9 *a*.

Fig. 138 *c*.—*Climacograptus styloideus*, Lapw. MS.

c

c. Distal thecæ. Enlargement of part of Pl. XXVII, fig. 9 *d*.

basal thecæ may give off spines from their free outer walls, these are but rarely seen. The virgula is sometimes expanded into a small disc towards its apical extremity; but at varying lengths from the distal end of the polypary. The width of the specimens varies with the mode of presentation; as a rule 2—2·5 mm. is the maximum in those which show only a scalariform view, but in those presented in true profile 3 mm. may be measured, though this greater width may be partly due to compression. The excavations, which appear as narrow elliptical slits, are very conspicuous in all states of preservation, and are invariably slightly oblique and inclined downward and inward.

Affinities.—*Cl. styloideus* is characterised by its relatively small breadth in comparison with its length and by the form of the proximal end. It presents a certain resemblance in size and form to *Cl. Scharenbergi*, but may be readily separated from well-preserved specimens of that graptolite by the absence of the zig-zag septal groove.

Horizon and Localities.—Hartfell Shales (zone of *Pleurog. linearis*).

S. Scotland: Dobb's Linn; Hartfell; Glenkiln; Craigmichan Scaurs.

Associates, etc.—*Cl. styloideus* is confined to the Hartfell Shales; it is a rare fossil in the zone of *Pleurog. linearis*, and occurs associated with the zone fossil.

Collection.—Lapworth.

Group III.

Climacograpti in which the free edge of the theca is practically straight and vertical, and the apertural margin slightly introverted and introtorted.

Climacograptus Scharenbergi, Lapworth. Plate XXVII, figs. 14 *a*—*e*.

1851. *Prionotus*, Boeck, Bemaerkninger angaaende Graptolitherne, pl. i, figs. 3, 10, 15, 18.

1851. *Graptolithus* (*Diplograpsus*) *teretiusculus*, Scharenberg, Ueber Graptoliten, pl. ii, figs. 23 *a*, 24 *a*, 25 *a*, 31 *a*.

1852. *Diplograpsus teretiusculus*, Salter, Quart. Journ. Geol. Soc., vol. viii, pl. xxi, fig. 3 *d*.
1875. *Diplograptus dentatus*, Hopkinson, Quart. Journ. Geol. Soc., vol. xxxi, pl. xxiv, fig. 5 *a*.
1876. *Climacograptus Scharenbergi*, Lapworth, Cat. West Scot. Foss., pl. ii, fig. 55.
1877. *Climacograptus Scharenbergi*, Lapworth, Proc. Belfast Nat. Field Club, p. 138, pl. vi, fig. 36.
1898. *Climacograptus Scharenbergi*, Elles, Quart. Journ. Geol. Soc., vol. liv, p. 519.

Polypary 1 to 4 cm. in length, widening almost at once to a maximum width of about 1·5 mm., and maintaining this breadth almost to its distal extremity. Sicula 0·5 mm. in length with robust virgella. Septal groove well-marked, conspicuously zig-zag in form. Thecæ fourteen to eleven in 10 mm., markedly alternate, short, overlapping one-third to one-fourth their length, and having their distal extremities very slightly introverted and introtorted; apertural margins situated in wide and deep excavations occupying one-fourth of the ventral margin of the polypary and about one-third of its width.

Description.—The specimens vary greatly in length, but all have an average width of 1·5 mm. The breadth at the proximal end is 0·6 mm., but the increase takes place so rapidly that the maximum width is attained at a distance of 6 mm. from the proximal end.

FIGS. 139 *a* to *c*. — *Climacograptus Scharenbergi*, Lapw.

a *b* *c*

a. Obverse view, showing sicula. Dobb's Linn, Lower Hartfell Shales (zone of *Cl. Wilsoni*). Coll. Wood.
b. Reverse (?) view, in relief, showing septal groove and long virgella. Ibid.
c. Reverse view, specimen showing very stout rod-like virgella. Ibid.

In the *obverse view* of the polypary the sicula is only visible in part in mature specimens, its apical region being imbedded apparently as a result of the growth of th. 2^2 across it in front; judging, however, from young specimens, it must have measured fully 1 mm. in length. Th. 1^1 appears to originate 5 mm. above the aperture of the sicula and grows downward to the level of the aperture, then bending round abruptly, grows upward and outward; from it there is developed th. 1^2, which in its initial region crosses the sicula obliquely, leaving it free for a short distance on the right side. Th. 2^1 is developed from th. 1^2, and from th. 2^1 two thecæ grow, namely th. 2^2 and th. 3^1; at this point the septum makes its appearance, but in the obverse aspect it is seen earlier.

In the *reverse view* of the polypary the mode of origin of the thecæ is clearly seen, and in some specimens the base of the sicula is visible, but in others it is obscured by the stout virgella, which may exceed 1 mm. in length.

The septal groove is distinctly angulated, running in short zig-zags from side to side. From the outer part of each angulation proceeds a short horizontal groove continuous with that of the septal groove itself.

The thecæ are highly characteristic (see Fig. 116), exhibiting a well-marked sigmoid curvature which is most sudden in its central part, and having their apertural margin slightly introverted. They grow at first upward, then bend outward almost at right angles, and finally turn upward at right angles, appearing to undergo a certain amount of torsion in the process. They are markedly alternate. The apertural margins are situated in wide, deep excavations which occupy about one-third the width of the polypary in the distal region, but rather less proximally.

The virgula may be distally prolonged for a distance of from 2 to 3 cm. When compressed the characteristic zig-zag septal groove is often indiscernible. In the scalariform view the thecæ present few of their characteristic features; there remain, therefore, only the general outline with its sub-parallel sides and the character of the proximal end for purposes of identification.

Affinities.—The zig-zag septal groove is highly characteristic; it is found in two other species, *Cl. Hughesi* and *Cl. extremus*, but these are both more diminutive species in every way. The shape of the proximal end and the characters of the thecæ are sufficient to distinguish the form when well preserved.

Horizon and Localities.—Upper Arenig (zone of *Didymog. bifidus*) to Lower Hartfell (zone of *Cl. Wilsoni*).

S. Scotland: Dobb's Linn; Hartfell; Glenkiln Burn; Craigmichan Scaurs; Black Linn; Balclatchie Bridge; Laggan Gill; Penwhapple Glen, etc. *Wales:* Tiddyndicwm; Pont Seiont; Llanvirn; Porth Hayog, Ramsey Island. *Lake District:* Thornship Beck. *Ireland:* Ballygrot; Craigavad; Coalpit Bay.

Associates, etc.—*Cl. Scharenbergi* has a fairly long range in time, from the Upper Arenig to the Lower Hartfell, but it is very rare in rocks of Upper Arenig age. It seems to attain its maximum in individuals in the Upper Glenkiln Shales and Lowest Hartfell Shales of S. Scotland.

In the Upper Arenig rocks of Pont Seiont and Porth Hayog it occurs associated with *Didymog. bifidus* and *Cl.* (?) *confertus*; in the Glenkiln Shales its companions are *Nemog. gracilis*, *Dicellog. sextans*, and *Cl. bicornis*, and in the Lowest Hartfells it occurs with *Cl. Wilsoni*, *Cl. bicornis*, and *Dicranog. Nicholsoni*.

Collections.—Sedgwick Museum, Lapworth, and the Authors.

Climacograptus Hughesi (Nicholson). Plate XXVII, figs. 11 *a*—*e*.

1853. *Diplograpsus teretiusculus*, Richter, Zeitschr. d. deutsch. geol. Gesell., vol. v, p. 456, pl. xii, figs. 11—13.

1869. *Diplograpsus Hughesi*, Nicholson, Ann. Mag. Nat. Hist., ser. 4, vol. iv, p. 234.

1871. *Diplograptus teretiusculus*, Richter, Zeitschr. d. deutsch. geol. Gesell., vol. xxiii, pl. v, figs. 5—7.

1876. Non *Diplograptus Hughesi*, Lapworth, Cat. West Scot. Foss., pl. ii, fig. 37.

1882. *Climacograptus undulatus*, Kurck, Geol. Fören. i. Stockh. Förhandl., vol. vi, p. 303, pl. xiv, fig. 11.

1890. *Climacograptus internexus*, Törnquist, Siljansomr. Graptol. I, Acta Univ. Lund., vol. xxiv, p. 25, pl. ii, figs. 8, 9.

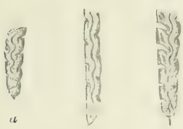
1893. *Climacograptus internexus*, Törnquist, Struct. Diprionidæ, Acta Univ. Lund., vol. xxix, p. 6, figs. 23—27.

1897. *Climacograptus undulatus*, Törnquist, Acta Reg. Soc. Physiogr. Lund., vol. viii, p. 9, pl. i, figs 22—24.

Polypary 5—10 mm. in length, having an average uniform breadth of rather less than 1 mm. for the greater part of its length but narrowing slightly at the proximal end, which is rounded off. Sicula visible for fully 0·5 mm. of its length, situated obliquely, virgella short. Thecæ sixteen to twelve in 10 mm., short tubes in contact for a small fraction of their length. Apertural margins introverted and introtorted, situated in apertural excavations occupying one-third the width of the ventral margin of the stipe and one-third the total width. Septum always undulating.

Description.—*Cl. Hughesi* resembles closely a minute *Cl. Scharenbergi*, and owing to the degree of introversion and introtorsion of the thecæ presents a very different appearance in the obverse and reverse aspects, and perhaps this is the reason that two species have been made out of this form. In the obverse aspect the sicula is visible for fully 0·5 mm. of its length, and is seen to be situated somewhat obliquely within the polypary. Th. 1¹ originates midway along its visible length, and growing outward and upward has its aperture on a level with the apex of the sicula.

FIGS. 140 *a*—*c*.—*Climacograptus Hughesi* (Nich.).



a *b* *c*

a. Small but typical specimen in relief. Ambleside Skelgill Beds. One of Nicholson's original specimens. Brit. Mus. (Nat. Hist.).
b. Compressed specimen in relief, obverse view, showing apical part of sicula. Enlargement of part of Pl. XXVII, fig. 11 *b*.
c. Well-preserved specimen, obverse view, showing sicula and origin of th. 1¹. Twymyn River, near Llanbrynmair, Dolgadfan Beds. Coll. Wood.

FIG. 140 *d*. — *Climacograptus Hughesi* (Nich.).

d

d. Distal thecæ, showing introversion and introtorsion of the apertural margins. Twymyn River, Pennant, Dolgadfan Beds. Coll. Wood.

In the reverse view the growth of the two earliest thecæ entirely conceals the sicula except for a small fraction of the apertural region. The thecal walls, while generally rectangular, show often a degree of sinuosity in their free outer part, but in the apertural region they seem to have undergone some slight introtorsion, so that the apertures are all directed towards the obverse side; this is only noticeable in specimens preserved in relief. When compressed the lower half of the apertural excavation may appear perpendicular or slightly oblique. Striæ marking stages of growth can usually be detected. There is a certain amount of variation in breadth in different specimens, between 0·6 mm. and 1 mm., but individuals are of uniform width throughout their whole extent.

Affinities.—*Cl. Hughesi* resembles *Cl extremus* in the undulating nature of its septal groove, but

Cl. extremus is altogether a much smaller and narrower species. *Cl. Hughesi* is the same form as that described by Kurck as *Cl. undulatus*; he noticed its similarity, but thought it distinct.

Horizon and Localities.—Birkhill Shales (zones of *C. acuminatus*, *D. vesiculosus*, *M. gregarius* and *C. cometa*).

S. Scotland: Dobb's Linn. *Lake District:* Skelgill. *Ireland:* Coalpit Bay, Donaghadee. *Wales:* River Twymyn, near Llanbrynmair.

Associates, etc.—*Cl. Hughesi* is a fairly common fossil in the Lower Birkhill Shales. It occurs throughout the basal zones, but is most abundant in the zones of *M. gregarius* and *C. cometa*, where it is found associated with *M. gregarius*, *M. cyphus*, *M. triangulatus*, *C. cometa*, *M. lobiferus*, etc.

Collections.—Sedgwick Museum, British Museum (Natural History), Lapworth, and the Authors.

Climacograptus extremus, H. Lapworth. Plate XXVII, figs. 13 *a*, *b*.

1900. *Climacograptus extremus*, H. Lapworth, Quart. Journ. Geol. Soc., vol. lvi, p. 134, figs. 22 A and 22 B *a—e*.

Polypary from 0·5 to 1 cm. in length, and with an average breadth of 0·5 mm., with rounded proximal end. Sicula and virgula unknown, virgella short. Thecæ regularly alternate, twenty to fifteen in 10 mm. Apertural margins small, introverted and introtorted, excavations occupying a small fraction of the total width of the polypary. Septum undulating.

Description.—The polypary may attain a length of over 1 cm., but smaller specimens with a length of about 5 mm. are of commoner occurrence. The free edges of the thecæ may be vertical or strongly concave.

FIGS. 141 *a—c*.—*Climacograptus extremus*, H. Lapw.

a b c

a. One of type specimens, incomplete. Rhyd Hir Brook, Rhayader, Rhayader Pale Shales. Coll. H. Lapworth.
b. Complete specimen in relief, reverse view, showing form of thecæ and septum. Enlargement of Pl. XXVII, fig. 13 *a*.
c. Fragment, reverse view. Same locality as Fig. 141 *a*.

The septal groove is a very characteristic feature; it runs from immediately below the aperture of one theca to a corresponding position in the succeeding theca of the opposite series, and is gently undulating or sharply angulated according to the variation in compression.

Affinities.—*Cl. extremus* agrees with *Cl. Hughesi* in the possession of an undulating septum, and in general characters of the thecæ. From *Cl. Hughesi*, however, it may be separated by (*a*) its smaller size, (*b*) the characters of the proximal end.

Horizon and Locality.—Tarannon Shales (base of Rhayader Pale Shales).

Wales : Rhayader ; Pennant Valley. *Lake District :* Skelgill (?).

Associates, etc.—Cl. extremus, according to Dr. H. Lapworth, is the commonest fossil at the base of the Rhayader Pale Shales, where it is associated with *M. crassus*, *M. pardus*, and *M. Becki*. The type specimens are in his collection.

Climacograptus minutus, Carruthers. Plate XXVII, figs. 12 *a—c*.

1868. *Climacograptus minutus*, Carruthers, Geol. Mag., vol. v, p. 132, pl. v, figs. 10 *a, b*.

Polypary less than 1 cm. in length, having a maximum width of 1 mm. attained by gradual widening from origin. Sicula visible for 0·5 mm. of its length, which is about 1 mm. Virgella slender but conspicuous, having a length of 1 mm. Virgula distally prolonged. Thecæ sixteen to twelve in 10 mm ; alternate, having a length of about 1 mm. and overlapping for half their extent ; apertural margins situated in shallow sub-elliptical depressions occupying about one-third of the total width of the stipe.

Description.—The polypary commonly measures about 6 or 8 mm. in length, and widens within the first 5 mm. to its maximum width of 1 mm. ; it is only about 0·3 mm. wide near its origin.

FIG. 142.—*Climacograptus minutus*, Carr.

Proximal end. Enlargement of specimen on same slab as Pl. XXVII, figs. 12 *a—c*.

Details respecting the thecæ are somewhat uncertain ; the free edge is straight and rectangular in profile view, and the apertural margins are then horizontal, but when seen in any other aspect they appear somewhat oblique.

Affinities.—The type specimens of *Cl. minutus* present a striking resemblance to compressed specimens of *Cl. Hughesi*, though in their unsatisfactory state of preservation it is not possible to state definitely that they are the same, and the species is therefore provisionally retained.

Cl. minutus is closely allied to *Cl. brevis* in point of size and in the general characters of the thecæ, but while in *Cl. minutus* the thecal apertures are alternate, in *Cl. brevis* they are opposite and somewhat wider.

Horizon and Localities.—Lower Birkhill Shales.

S. Scotland : Dobb's Linn, Moffat ; Frenchland Burn. *Lake District :* Skelgill (*Dimorphog. confertus* zone). *Ireland :* Coalpit Bay, Donaghadee.

Associates, etc.—Cl. minutus is a rare fossil in the lower beds of the Birkhill Shales, where it occurs in association with *Dimorphograptus Swanstoni*, a characteristic fossil of the zone of *Diplog. vesiculosus*. It also occurs in the Stockdale Shales (*confertus* zone) associated with *Dimorphog. Swanstoni* and the zone fossil. Carruthers' type specimens, from which the above description was drawn up, are

in the British Museum (Natural History). The best Irish specimens are in the Collection of the Belfast Naturalists' Field Club, while those from the Lake District were collected by Dr. J. E. Marr, and are now in the Sedgwick Museum.

Group IV.

Climacograpti in which the straight and vertical free edge of the theca is provided with a mesial spine, and the apertural margin tends to be slightly introverted.

Climacograptus innotatus, Nicholson. Plate XXVII, figs. 10 *a*—*e*.

1869. *Climacograptus innotatus*, Nicholson, Ann. Mag. Nat. Hist., ser. 4, vol. iv, p. 238, pl. xi, figs. 16, 17.

1870. *Climacograptus innotatus*, Nicholson, Ann. Mag. Nat. Hist., ser. 4, vol. vi, p. 384.

1876. *Climacograptus innotatus*, Lapworth, Cat. West Scot. Foss., pl. ii, fig. 54.

1877. *Climacograptus innotatus*, Lapworth, Grap. Co. Down, p. 140, pl. vi, fig. 37.

Polypary small, 5—6 mm. in length, with a uniform average width of 1·5 mm. exclusive of the spines. Sicula 1 mm. in length, virgella short and fine. Thecæ fourteen in 10 mm., short, about 1 mm. in length, in contact only. Apertural margins horizontal, opening within wide semicircular excavations, which are of the same extent as the free edge of each theca, from the mesial angle of which a short and conspicuous spine projects.

Description.—The spined nature of the thecæ is highly characteristic of this species, as is also its small size and uniformly narrow width. The sicula is small; it reaches to the level of the aperture of th. 1², the initial part of which crosses it obliquely, leaving it free on one side for a small fraction of its length. The virgula is often slightly prolonged distally.

Figs. 143 *a* and *b*.—*Climacograptus innotatus*, Nich.

a Specimen showing typical form of the thecæ and their mesial spines. Long Linn, Dobb's Linn; Birkhill Shales (zone of *Monog. gregarius*). Coll. Elles.

b. Poorly preserved but complete specimen showing portion of sicula and virgula. On same slab as Pl. XXVII, fig. 10*c*.

Affinities.—In the spined nature of the thecæ the polypary shows undoubted affinities with the *Lasiograpti*, but in other respects the characters are those of a true *Climacograptus*, from all species of which, however, the presence of the spines is sufficient to distinguish it.

Horizon and Localities.—Lower Birkhill Shales, zones of *Cephalog. acuminatus*, *D. vesiculosus*, and *M. gregarius*.

S. Scotland: Dobb's Linn; Long Linn, Lockerbie; Thirlstane Burn. *Ireland:* Donaghadee.

Associates, etc.—*Cl. innotatus* is a fairly abundant fossil in the Birkhill Shales of S. Scotland and Ireland. It occurs associated with *Cephalog. acuminatus*, *Diplog. vesiculosus*, *Climacog. scalaris* var. *normalis*, *Cl. rectangularis*, *Monog. tenuis*, and *Monog. gregarius*.

Collections.—Sedgwick Museum, British Museum (Natural History), Lapworth, and the Authors.

Group V.

Climacograpti in which the free edge of the theca is slightly inclined, and the apertural margins are thickened and produced into spines.

Climacograptus tuberculatus, Nicholson. Plate XXVI, figs. 7 *a—d*.

1869. *Climacograptus tuberculatus*, Nicholson, Ann. Mag. Nat. Hist., ser. 4, vol. iv, p. 239.

Polypary 1—2 cm. in length, widening fairly rapidly to a maximum breadth of 2 mm., which is then maintained up to the distal extremity; proximal end adorned with two short, stout, curved or horizontal spines. Sicula unknown. Thecæ twelve to ten in 10 mm., alternate, free edges straight or with slight concave curvature, overlap small; apertural margins situated in shallow elliptical depressions occupying one-fourth to one-third the width of the polypary, and having their lateral angles adorned with a linear series of tubercles.

Description.—All known specimens of *Cl. tuberculatus* are poorly preserved. The polypary attains its maximum width fairly quickly; proximally it is only 0·5 mm. wide, but this dimension is doubled within the first millimetre of length, and the same rate of increase is maintained. The spines at the base are shorter and stouter in proportion than those of *Cl. bicornis*, and they are commonly directed horizontally at first, though subsequently they may be slightly curved and directed somewhat obliquely downward. The virgella is conspicuous but small. The so-called tubercles on the lateral edges of the apertures are best seen

Fig. 144 *a*.—*Climacograptus tuberculatus*, Nich.

a.

Proximal end, showing thickening of apertural margins and spines. Dobb's Linn, Lower Birkhill Shales. Coll. British Museum (Nat. Hist.).

Fig. 144 *b*.—*Climacograptus tuberculatus*, Nich.

b.

b. Distal thecæ showing form of apertures. Ibid.

in the scalariform view of the polypary, and appear to be the thickened edges of the apertural margins which tend to be produced into short curved spines. This feature is conspicuous at the proximal end but is less marked at the distal extremity.

Affinities.—Exception being made of the tubercles and the basal spines, the species resembles *Cl. scalaris* in form, but the presence of these features should suffice to distinguish it in all cases. From *Cl. bicornis* it differs in the characters of the spines and also in the number of thecæ in the same unit of length.

Horizon and Locality.—Highest Hartfell Shales (zone of *Dicellog. anceps*) and base of Birkhill Shales (zone of *Cephalog. acuminatus*).

S. Scotland: Dobb's Linn.

Associates, etc.—*Cl. tuberculatus* is a rare fossil in the beds at the junction of the Hartfell and Birkhill Shales in Dobb's Linn. It is associated with *Cl. scalaris* and *Dimorphograptus sp.*

The type specimens are in the British Museum (Natural History).

Specific Characters of Forms belonging to the Genus CLIMACOGRAPTUS.

	GROUP I.													
	Cl. scalaris.			*Cl. rectangularis.*	*Cl. medius.*	*Cl. Törnquisti.*	*Cl. minimus.*	*Cl. brevis.*	*Cl. bicornis.*			*Cl. supernus.*	*Cl. Wilsoni.*	
		var. *normalis.*	var. *miserabilis.*							var. *tridentatus.*	var. *peltifer.*			var. *tubularis.*
Character of polypary	Short, parallel-sided	Long	Medium	Long, tapering	Medium, approximately parallel-sided	Tapering	Short, parallel-sided	Very short	Very long and tapering	—	—	Short	Very long, tapering	—
Septum	Complete	—	—	Nearly complete	Partial	Partial	?	?	Nearly complete	—	—	—	—	—
Average width	1·5 mm.	1—1·5 cm.	·8 mm.	2·5 mm.	—	2 mm.	– 2 mm.	1 mm.	2·5 mm.	—	—	1·2 mm.	2·5 mm.	—
Length of sicula (visible portion)	0·6 mm.	—	?	1 mm.	1·5 mm	2 mm.	1 mm.	—	·5 mm.	—	—	—	2·5 mm.	—
Character of proximal end	Rounded, virgella short and slender	Sicula free ½ length, virgella short and robust	—	—	Long virgella	Very long tubular virgella, sicula free on one side	Like *Cl. scalaris*	Like var. *normalis*	2 conspicuous basal spines	3 conspicuous basal spines	Enclosed in a disc	2 slender basal spines	Furnished with elliptical sac	Furnished with long tube
Characters of thecæ: 1. No. in 10 mm.	11—9	10—9	11—10	12—10	—	—	14—11	14—10	12—10	—	—	14–12	12—8	—
2. Free edge	Straight	—	—	—	—	—	—	—	—	—	—	—	Nearly straight or slightly inclined	—
3. Apertural margin	Horizontal	—	—	—	—	—	—	—	—	—	—	—	—	—
4. Excavation	Semicircular	—	—	—	—	—	—	—	Elliptical	—	—	—	Semicircular	—
	$\frac{1}{3}$–$\frac{1}{4}$ ventral margin of polypary	¼ ventral margin	—	½ ventral margin	⅓ ventral margin	—	¼ ventral margin	⅓ ventral margin	—	—	—	—	¼ ventral margin	—
	¼ width of polypary	—	—	⅕ width of polypary	—	¼ width of polypary	⅓ width of polypary	¼ width of polypary	—	—	⅕ breadth of polypary	¼ breadth of polypary	—	—

Specific Characters of Forms belonging to the Genus Climacograptus—continued.

	GROUP II.							GROUP III.				GROUP IV.	GROUP V.
	Cl. antiquus.			*Cl. caudatus.*	*Cl. tubuliferus.*	*Cl. latus.*	*Cl. styloidus.*	*Cl. Scharenbergi.*	*Cl. Hughesi.*	*Cl. minutus.*	*Cl. extremus.*	*Cl. innotatus.*	*Cl. tuberculatus.*
		var. *lineatus.*	var. *bursifer.*										
Character of polypary	Long, parallel-sided	Very long	Long	Very long and tapering	Long, with conspicuous median tube	Short, slightly tapering	Long, parallel-sided	Medium, parallel-sided	Short	—	Very short	Very short, parallel-sided	Short, parallel-sided
Septum	?	?	?	?	?	?	?	Zig-zag septal groove	—	?	Zig-zag septal groove	—	?
Average width	2·5 mm.	2 mm.	2—2·5 mm.	—	—	—	—	1·5 mm.	1 mm.	1 mm.	·5 mm.	1·5 mm.	2 mm.
Length of sicula	?	?	?	?	1 mm.	·5 mm.	?	·5 mm.	—	—	—	1 mm.	?
Character of proximal end	2 small basal spines, very long virgella	Short virgella	Furnished with sac	Passing insensibly into tube partially surrounding very long virgella	Very stout rod-like virgella with partial membrane	Three slender spines	Rounded, with conspicuous short virgella	Rounded, with short and conspicuous virgella	Rounded, with inconspicuous virgella	cfr. *Hughesi*	Rounded, with very short virgella	Unsymmetrical	Three conspicuous spines
Characters of thecæ:													
1. No. in 10 mm.	11—9	8—9	14—12	12—9	12—8	13—10	12—8	14—11	16—12	—	20—15	14	12—10
2. Free edge	Slightly inclined	—	—	Distinctly inclined	Slightly inclined	Very slightly inclined	—	Straight	Slightly inclined	—	—	Straight, with conspicuous spine at mesial angle	Slightly inclined
3. Apertural margin	Slightly introverted	—	—	—	—	—	Decidedly introverted	Introverted and introtorted	—	—	—	Very slightly everted	Thickened edges produced into spines
4. Excavation	Wide and deep	—	—	—	—	—	—	—	—	—	—	Wide and deep	—
	$\frac{1}{3}$–$\frac{1}{4}$ ventral margin of polypary	—	—	$\frac{1}{3}$ ventral margin	$\frac{1}{4}$ ventral margin	$\frac{1}{3}$ ventral margin	$\frac{1}{4}$ ventral margin	$\frac{1}{4}$ ventral margin	$\frac{1}{3}$–$\frac{1}{4}$ ventral margin	—	$\frac{1}{3}$–$\frac{1}{4}$ ventral margin	$\frac{1}{2}$ ventral margin	
	$\frac{1}{4}$–$\frac{1}{5}$ breadth of polypary	—	—	$\frac{1}{4}$ breadth of polypary	$\frac{1}{4}$–$\frac{1}{6}$ width of polypary	$\frac{1}{4}$–$\frac{1}{5}$ width of polypary	$\frac{1}{3}$–$\frac{1}{4}$ width of polypary	$\frac{1}{3}$ width of polypary	—	—	—	$\frac{1}{4}$ width of polypary	?

PLATE XXVI.

Genus **Climacograptus.**

FIGS.

1 *a—c.—Climacograptus scalaris* (Hisinger). (Page 184.)
- 1 *a.* Specimen showing proximal end. Belcraig Burn, S. Scotland. Upper Birkhill Shales. Hopkinson Collection, Sedgwick Museum.
- 1 *b.* Incomplete specimen. Ibid. Elles' Collection.
- 1 *c.* Larger specimen. Donaghadee, Ireland. Birkhill Shales. Elles' Collection.

2 *a—g.—Climacograptus scalaris,* var. *normalis,* Lapworth. (Page 186.)
- 2 *a.* Type specimen. Figured, Lapworth, Graptolites of Co. Down, 1877, pl. vi, fig. 31. Lower Birkhill Shales (zone of *Cephalog. acuminatus*). Dobb's Linn. Lapworth's Collection.
- 2 *b.* Narrow specimen showing sicula. Ibid. Elles' Collection.
- 2 *c.* Reverse view. Ibid.
- 2 *d.* Long specimen. Ibid. H. Lapworth's Collection.
- 2 *e.* Specimen with long distal virgula. Ibid.
- 2 *f.* Obverse view. Ibid.
- 2 *g.* Specimen in low relief. North Cliff, Dobb's Linn. Lapworth's Collection.

3 *a—h.—Climacograptus scalaris,* var. *miserabilis,* Elles and Wood, nov. (Page 186.)
- 3 *a.* Complete specimen. Dobb's Linn. Upper Hartfell Shales (zone of *Dicellog. complanatus*). Lapworth's Collection.
- 3 *b.* Incomplete specimen. Ibid.
- 3 *c.* Specimen showing proximal end. Ibid.
- 3 *d.* Ditto. Ibid.
- 3 *e.* Ibid.
- 3 *f.* Narrow form (?) Upper Hartfell Shales (zone of *Dicellog. anceps*). Dobb's Linn. Wood's Collection.
- 3 *g.* Slender parallel-sided form, doubtfully referable to this variety. Ibid. Elles' Collection.
- 3 *h.* Ibid.

4 *a—f.—Climacograptus medius,* Törnquist. (Page 189.)
- 4 *a.* Complete and typical specimen. Lower Birkhill Shales (zone of *Diplog. vesiculosus*). Dobb's Linn. Sedgwick Museum.
- 4 *b.* Specimen which tapers more at the proximal end. Lower Birkhill Shales (zone of *Diplog. vesiculosus*). Main Cliff, Dobb's Linn. Elles' Collection.
- 4 *c.* Distal fragment. On same slab as fig. 4 *a*.
- 4 *d.* Young specimen preserved as a cast, showing incomplete septum. Fachdre Beds (zone of *Dimorphograptus*), Plas Pennant, Llanbrynmair. Wood's Collection.
- 4 *e.* Young specimen, showing long virgella. Same slab as figs. 4 *a* and 4 *c*.
- 4 *f.* Ditto, showing two long proximal spines. Ibid.

5 *a—e.—Climacograptus rectangularis* (M'Coy). (Page 187.)
- 5 *a.* Type specimen in relief. Figured, M'Coy, British Palæozoic Fossils, pl. i B, fig. 8 *a*. Birkhill Shales. Moffat. Sedgwick Museum.
- 5 *b.* Cast of same. Fig. 8.
- 5 *c.* Longer specimen, preserved in scalariform view. Ibid. Fig. 9.
- 5 *d.* Small incomplete specimen. Birkhill Shales. Moffat. Sedgwick Museum.
- 5 *e.* Ibid.

6 *a—f.—Climacograptus Törnquisti,* Elles and Wood, sp. nov. (Page 190.)
- 6 *a.* ? Specimen figured, Lapworth, as *C. rectangularis,* Graptolites of Co. Down, 1877, pl. vi, fig. 32. Dobb's Linn. Birkhill Shales. Lapworth's Collection.
- 6 *b.* Smaller specimen, showing reverse view, on same slab as fig. 6 *a*.
- 6 *c.* Larger specimen, showing tubular virgella. Dobb's Linn. Birkhill Shales. Lapworth's Collection.
- 6 *d.* Ditto, preserved in scalariform view. Ibid.
- 6 *e.* Specimen with very long tubular virgella. Obverse view. Ibid.
- 6 *f.* Small well-preserved specimen, reverse view. Waterfall, Long Cliff, Dobb's Linn. Birkhill Shales. Lapworth's Collection.

FIGS.

7 *a*—*d*.—*Climacograptus tuberculatus*, Nicholson. (Page 213.)

7 *a*. Complete specimen, poorly preserved. Dobb's Linn. Lower Birkhill Shales. British Museum (Natural History), S. Kensington.

7 *b*. Ibid.

7 *c*. Ibid.

7 *d*. Ibid.?

8 *a*—*f*.—*Climacograptus bicornis* (Hall). (Page 193.)

8 *a*. Specimen in full relief; obverse view. Dobb's Linn. Lower Hartfell Shales (zone of *Climacog. Wilsoni*). Elles' Collection.

8 *b*. Slender specimen with small proximal spines. Kirkton Burn, Wanlock Head. Glenkiln Shales. Lapworth's Collection.

8 *c*. Long specimen. Glenkiln Burn. Lower Hartfell Shales (zone of *Climacog. Wilsoni*). Wood's Collection.

8 *d*. Scalariform view of specimen with stout spines. The Cornice, Hartfell. Hartfell Shales. Lapworth's Collection.

8 *e*. Specimen with very long slender spines. The Cornice, Hartfell. Hartfell Shales (zone of *Climacog. Wilsoni*). Elles' Collection.

8 *f*. Ibid.

9 *a*—*c*.—*Climacograptus bicornis*, var. *tridentatus*, Lapworth. (Page 195.)

9 *a*. Specimen with short virgella. Glenkiln. Glenkiln Shales. Lapworth's Collection.

9 *b*. Specimen with three equally prominent spines. Wanlock Water. Glenkiln Shales. Lapworth's Collection. (The reverse side of this specimen is in the Sedgwick Museum.)

9 *c*. Specimen with shorter spines enclosed in prominent disc. Glenkiln. Glenkiln Shales. Lapworth's Collection.

10 *a*—*c*.—*Climacograptus bicornis*, var. *peltifer*, Lapworth. (Page 196.)

10 *a*. Specimen with proximal spines enclosed in a small disc. Dobb's Linn. Upper Glenkiln Shales. Wood's Collection.

10 *b*. Small specimen with large disc enveloping proximal end of polypary. Tiddyndicwm, N. Wales. Upper Glenkiln Shales. Sedgwick Museum.

10 *c*. Typical specimen. Dobb's Linn. Glenkiln Shales. Lapworth's Collection.

11 *a*—*d*.—*Climacograptus supernus*, Elles and Wood, sp. nov. (Page 196.)

11 *a*. Typical specimen. Main Cliff, Dobb's Linn. Upper Hartfell Shales (zone of *Dicellog. anceps*). Wood's Collection.

11 *b*. Ibid. Elles' Collection.

11 *c*. Ibid. Wood's Collection.

11 *d*. Specimen showing virgella and short spines. Ibid.

12 *a*—*d*.—*Climacograptus Wilsoni*, Lapworth. (Page 197.)

12 *a*. Typical specimen in partial relief. Main Cliff, Dobb's Linn. Lower Hartfell Shales (zone of *Climacog. Wilsoni*). Lapworth's Collection.

12 *b*. Specimen showing distorted position of sac. Ibid.

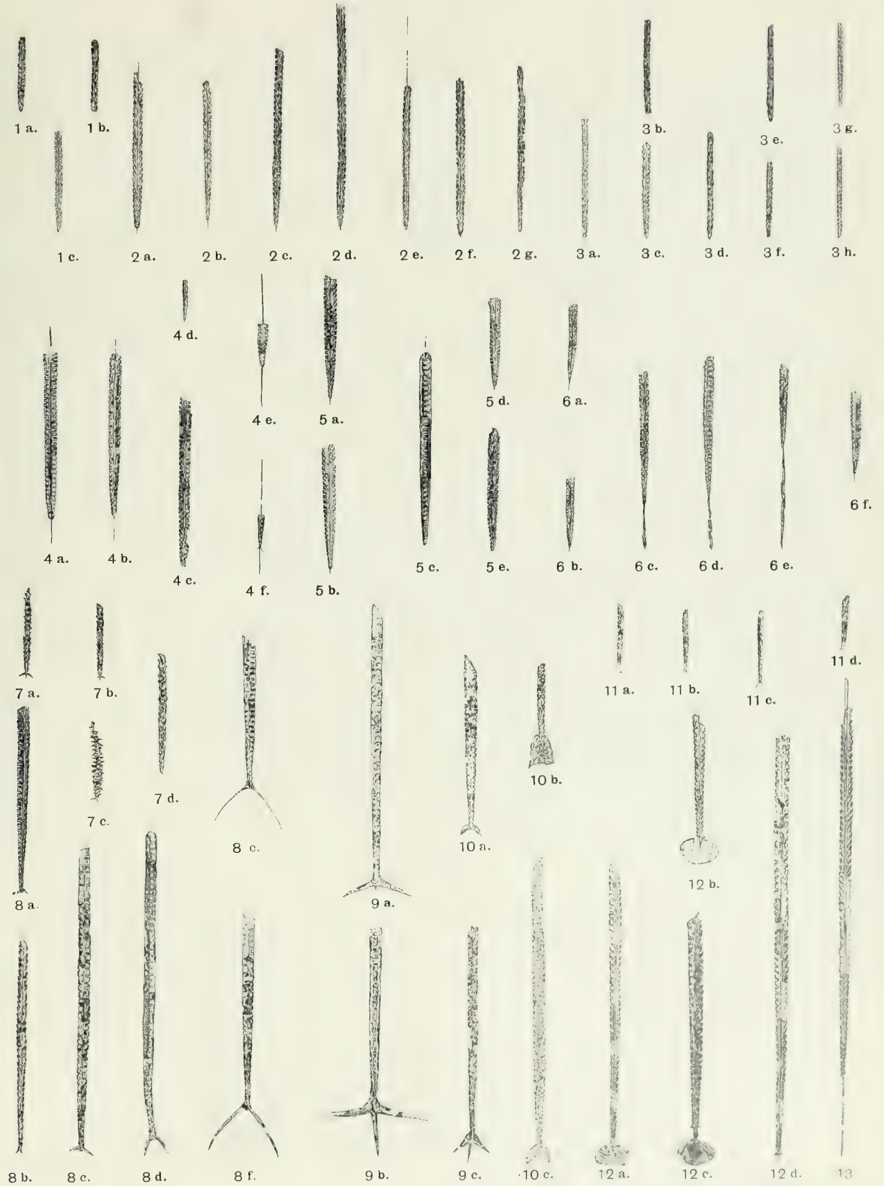
12 *c*. Specimen with sac in normal position. Ibid.

12 *d*. Long specimen in partial relief, sac broken off. Ibid.

13.—*Climacograptus Wilsoni*, var. *tubularis*, Elles and Wood, nov. (Page 199.)

13. Large specimen in relief showing long tubular virgella. Dobb's Linn. Lower Hartfell Shales (zone of *Climacog. Wilsoni*). Lapworth's Collection.

BRITISH GRAPTOLITES. *PLATE XXVI.*



E. M. K. Wood, del.

PLATE XXVII.

Climacograptus—*continued.*

FIGS.

1 *a—g.*—*Climacograptus minimus* (Carruthers). (Page 191.)

1 *a.* Complete specimen. Mount Benger Burn, S. Scotland. Hartfell Shales (zone of *Pleurog. linearis*). Lapworth's Collection.

1 *b.* Smaller specimen. On same slab as fig. 1 *a.*

1 *c.* Wider fragment. On same slab as figs. 1 *a* and 1 *b.*

1 *d.* Distal fragment, showing virgular tube. Dobb's Linn (zone of *P. linearis*). Elles' Collection.

1 *e.* Complete specimen, showing proximal end. Ibid.

1 *f.* Long specimen. Ibid.

1 *g.* Smaller specimen. Ibid.

2 *a—f.*—*Climacograptus brevis*, Elles and Wood, sp. nov. (Page 192.)

2 *a.* Typical specimen, reverse view, showing sicula. Gwern-y-fed-fach, Builth. Llandeilo Beds. Sedgwick Museum.

2 *b.* Specimen on same slab as fig. 2 *a.*

2 *c.* Smaller specimen. Ibid.

2 *d.* Complete specimen. Ibid.

2 *e.* Young specimen, obverse view, showing sicula. Dobb's Linn. Hartfell Shales (zone of *Pleurog. linearis*). Elles' Collection.

2 *f.* Dorsal view of wide specimen. Gwern-y-fed-fach, Builth. Llandeilo Beds. Elles' Collection.

3 *a—h.*—*Climacograptus latus*, Elles and Wood, sp. nov. (Page 204.)

3 *a.* Typical specimen, obverse view. Main Cliff, Dobb's Linn. Upper Hartfell Shales (zone of *Dicellog. anceps*). Elles' Collection.

3 *b.* Ibid. Wood's Collection.

3 *c.* Small specimen. Ibid. Elles' Collection.

3 *d.* Wide distal fragment. Ibid. Wood's Collection.

3 *e.* Small specimen. Ibid.

3 *f.* Larger specimen. Ibid.

3 *g.* Small narrow specimen, reverse view. Ibid. Elles' Collection.

3 *h.* Larger specimen, doubtfully referable to this species. Ibid. Wood's Collection.

4 *a—e.*—*Climacograptus antiquus*, Lapworth. (Page 199.)

4 *a.* Typical specimen. Black Linn, Glenkiln. Glenkiln Shales. Lapworth's Collection.

4 *b.* Large but incomplete specimen. Ibid.

4 *c.* Narrower specimen. Kirkmichael Burn, S. Scotland. Glenkiln Shales. Lapworth's Collection.

4 *d.* Specimen with prominent proximal spines. Oak Wood, Pontesford, Shropshire. Lower Bala. Lapworth's Collection.

4 *e.* Ibid.

5 *a—f.*—*Climacograptus antiquus*, var. *lineatus*, Elles and Wood, nov. (Page 201.)

5 *a.* Small but complete specimen. Craigmichan Scaurs, S. Scotland. Upper Glenkiln Shales (zone of *Dicellog. patulosus*). Lapworth's Collection.

5 *b.* Distal fragment. Ibid.

5 *c.* Long distal fragment, narrowed by compression. Llanystwmdwy. *Dicranograptus* Shales. Sedgwick Museum.

5 *d.* Proximal end of specimen preserved in scalariform view. Ibid.

5 *e.* Distal fragment. Ibid.

5 *f.* Distal fragment, not distorted. Ibid.

6 *a—d.*—*Climacograptus antiquus*, var. *bursifer*, Elles and Wood, nov. (Page 201.)

6 *a.* Typical specimen. Kirkmichael Burn, Dumfries. Glenkiln Shales. Lapworth's Collection.

6 *b.* Smaller specimen, showing distal prolongation of the virgula. On same slab as fig. 6 *a.*

6 *c.* Specimen showing proximal end and sac. On same slab as figs. 6 *a* and 6 *b.*

6 *d.* Small specimen with large sac. Same locality as figs. 6 *a—c.*

FIGS.

7 *a—e.*—*Climacograptus caudatus*, Lapworth. (Page 202.)

- 7 *a.*—Typical specimen with long virgella. Glenkiln Burn, Kirkmichael, Dumfries. Hartfell Shales. Lapworth's Collection.
- 7 *b.* Small specimen showing virgella and distal virgula. Ibid.
- 7 *c.* Specimen showing tubular virgella. Hartfell Spa. Ibid.
- 7 *d.* Typical form. Same locality as figs. 7 *a* and 7 *b.*
- 7 *e.* Specimen having a long proximal spine in addition to virgella. Same locality as fig. 7 *c.*

8 *a—d.*—*Climacograptus tubuliferus*, Lapworth. (Page 203.)

- 8 *a.* Typical specimen. Hartfell Spa. Hartfell Shales. Lapworth's Collection.
- 8 *b.* Ditto, showing broad virgular tube. On same slab as fig. 8 *a.*
- 8 *c.* Small specimen showing proximal end. Ibid.
- 8 *d.* Larger specimen. Ibid.

9 *a—e.*—*Climacograptus styloideus*, Lapworth. (Page 205.)

- 9 *a.* Typical specimen showing virgula with sac, scalariform view. Hartfell Spa. Hartfell Shales. Lapworth's Collection.
- 9 *b.* Distal fragment, showing virgula and sac. Ibid.
- 9 *c.* Proximal part. Ibid.
- 9 *d.* Wide specimen. Ibid.
- 9 *e.* Complete specimen, scalariform view. Ibid.

10 *a—e.*—*Climacograptus innotatus*, Nicholson. (Page 212.)

- 10 *a.* Typical specimen. Dobb's Linn. Birkhill Shales (zone of *Monog. gregarius*). Elles' Collection.
- 10 *b.* Small specimen showing thecal spines. Ibid.
- 10 *c.* Long narrow specimen with few thecal spines. Dobb's Linn. Birkhill Shales. Lapworth's Collection.
- 10 *d.* Small specimen, obverse view. Ibid. Elles' Collection.
- 10 *e.* Ibid.

11 *a—e.*—*Climacograptus Hughesi* (Nicholson). (Page 208.)

- 11 *a.* Typical specimen in full relief. Ambleside, Lake District. Skelgill Beds. British Museum (Natural History), S. Kensington.
- 11 *b.* Compressed specimen, in relief. Skelgill. Skelgill Beds (zone of *Monog. fimbriatus*). Marr's Collection.
- 11 *c.* Specimen in the flat. Branch Linn, Dobb's Linn. Birkhill Shales (zone of *M. gregarius*). Elles' Collection.
- 11 *d.* Small specimen, cast. Skelgill. Skelgill Beds (zone of *M. argenteus*). Marr's Collection.
- 11 *e.* Specimen preserved in the flat. Main Cliff, Dobb's Linn. Birkhill Shales. Elles' Collection.

12 *a—c.*—*Climacograptus minutus*, Carruthers. (Page 211.)

- 12 *a.* Complete specimen. Frenchland Burn, S. Scotland. Birkhill Shales. British Museum (Natural History), S. Kensington.
- 12 *b.* Ibid. On same slab as fig. 12 *a.*
- 12 *c.* Distal fragment. Ibid.

13 *a, b.*—*Climacograptus extremus*, H. Lapworth. (Page 210.)

- 13 *a.* Typical specimen in full relief, reverse view. Rhyd Hir Brook, Rhayader. Rhayader Pale Shales (zone of *Monog. crassus*). H. Lapworth's Collection.
- 13 *b.* Ibid.

14 *a—e.*—*Climacograptus Scharenbergi*, Lapworth. (Page 206.)

- 14 *a.* Typical specimen, full relief. Dobb's Linn. Lower Hartfell Shales (zone of *Climacog. Wilsoni*). Lapworth's Collection.
- 14 *b.* Large specimen in relief. Ibid.
- 14 *c.* Specimen preserved in the flat, showing no zig-zag septum. Hartfell Spa. Lower Hartfell Shales (zone of *Climacog. Wilsoni*). Lapworth's Collection.
- 14 *d.* Small specimen preserved as a cast, showing very long virgula. Ibid.
- 14 *e.* Small fragment. Pont Seiont, N. Wales. Upper Arenig Beds (zone of *Didymog. bifidus*). Sedgwick Museum.

PALÆONTOGRAPHICAL SOCIETY, 1906.

BRITISH GRAPTOLITES. PLATE XXVII.

E. M. R. Wood, del.